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TRANSACTIONS

OF THE

KANSAS ACADEMY OF SCIENCE,

VOL. XX, PART I.

CONTAINS

LIST OF OFFICERS, PAST AND PRESENT; MEMBERSHIP LIST JANUARY 10, 1906; THE PRESIDENT'S ADDRESS; MINUTES OF THE THIRTY-EIGHTH MEETING OF THE ACADEMY; ALSO, A FEW ILLUSTRATIONS AND SOME OF THE PAPERS PRESENTED.

J. T. LOVEWELL, SECRETARY.

STATE PRINTING OFFICE,
TOPEKA, 1906.
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TRANSACTIONS

OF THE

KANSAS

ACADEMY OF SCIENCE,

VOL. XX, PART I.

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LIST OF OFFICERS, PAST AND PRESENT; MEMBERSHIP LIST JANUARY 10, 1906; THE PRESIDENT'S ADDRESS; MINUTES OF THE THIRTY-EIGHTH MEETING OF THE ACADEMY; ALSO, A FEW ILLUSTRATIONS AND SOME OF THE PAPERS PRESENTED.

DECEMBER, 1905.

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MEMBERSHIP OF THE ACADEMY,

January 10, 1906.

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W. A. Kellerman, Ph. D., 1897, Ohio State University, Columbus, Ohio.
Edw. L. Nichols, Ph. D., 1897, Cornell University.... Ithaca, N. Y.
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Geo. Wagner, Phar. C., 1904, University of Wisconsin, Madison, Wis.
S. W. Williston, Ph. D., 1902, University of Chicago, Chicago, Ill.

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Dates printed in the following list signify date of election to membership in the Academy.

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F. W. Cragin, M. S., 1880..... Colorado Springs.
L. L. Dyche, M. S., 1881, University of Kansas..... Lawrence.
Geo. H. Failyer, Ph. D., 1879, Department of Agr.... Washington, D. C.
E. C. Franklin, Ph. D., 1884, Leland Stanford Jr. Univ., Stanford Univ., Cal.
I. D. Graham, 1879, *Kansas Farmer*..... Topeka.
Erasmus Haworth, Ph. D., 1882, University of Kansas, Lawrence.
Warren Knaus, M. S., editor McPherson *Democrat*... McPherson.
D. E. Lantz, M. S., 1887, Biological Survey..... Washington, D. C.
J. T. Lovewell, Ph. D., 1878, secretary Ac. of Sci.... Topeka.
F. O. Marvin, C. E., 1884, University of Kansas..... Lawrence.
J. R. Mead, 1879..... Wichita.
Ephraim Miller, Ph. D., 1873, University of Kansas.. Lawrence.
E. A. Popenoe, A. M., 1872, Kansas Agr. College.... Manhattan.
L. E. Sayre, Ph. M., 1885, University of Kansas..... Lawrence.
Alva J. Smith, 1903, county surveyor..... Emporia.
B. B. Smyth, 1880, curator Goss ornith. collection.... Topeka.
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A. H. Thompson, D. D. S., 1873..... Topeka.
D. M. Valentine, LL. D., 1878..... Topeka.
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Orr Adams, 1898..... Telluride, Colo.
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John J. Arthur, 1904..... Topeka.
W. R. Arthur, 1903, A. B., high school..... Logan.
C. H. Ashton, 1903, University of Kansas..... Lawrence.
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Harvey W. Baker, 1902, Kansas Agricultural College, Manhattan.
M. A. Barber, 1904, University of Kansas ..... Lawrence.
Elam Bartholomew, M. S., 1895..... Stockton.
Edward Bartow, Ph. D., 1897, University of Kansas.. Lawrence.
Wm. C. Bauer, A. M., 1897, Baker University..... Baldwin.
W. J. Baumgartner, 1904, University of Kansas ..... Lawrence.
Frank G. Bedell, 1904..... Iola.
J. W. Beede, Ph. D., 1894, University of Indiana..... Bloomington, Ind.
Edw. Bumgardner, M. D., 1896..... Lawrence.
F. W. Bushong, B. S., 1896, Kansas City University, Kansas City, Kan.
H. P. Cady, 1904, University of Kansas..... Lawrence.
M. E. Canty, 1903 ..... Buffalo.
Chas. I. Corp, 1905, University of Kansas..... Lawrence.
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F. F. Crevecœur, 1899..... Onaga.
Robert W. Curtis, Ph. D., 1904, University of Kansas, Lawrence.
F. B. Dains, Ph. D., 1902, Washburn College ..... Topeka.
R. E. Davis, 1904..... Fort Scott.
Geo. A. Dean, 1903, Kansas Agricultural College..... Manhattan.
Emil O. Deere, 1905, Bethany College..... Lindsborg.
S. D. Dice, 1904, public schools ..... Alma.
James Dickson, 1904, University of Kansas ..... Lawrence.
Hugo Diemer, M. E., 1903, University of Kansas .... Lawrence.
R. B. Dunlevy, B. S., 1896, Southwest Kansas College, Winfield.
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Harry Eagle, 1905, student ..... Topeka.
J. Whit Ebey, 1903, science teacher..... Howard.
H. W. Emerson, 1904, University of Kansas ..... Lawrence.
H. W. Ewing, D. D. S., 1903, Iola Gas Company..... Iola.
B. F. Eyer, B. S., 1894, Kansas Agricultural College, Manhattan.
Fred Faragher, 1904..... Lawrence.
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Lillian E. Fowler, 1905, Ottawa high school..... Ottawa.

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C. F. Gustafson, 1899, Kansas City high school..... Kansas City, Mo.
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H. J. Harnly, B. S., 1893, McPherson College..... McPherson.
W. A. Harshbarger, B. S., 1902, Washburn College... Topeka.
Frank Hartman, 1905, student..... Kansas City, Kan.
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H. D. Hess, 1904, University of Kansas..... Lawrence.
W. E. Henderson, 1901..... Iola.
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W. C. Hoad, 1904, University of Kansas..... Lawrence.
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Geo. H. Hoxie, M. D., 1902, University of Kansas... Lawrence.
W. F. Hoyt, A. M., 1902, Kansas Wesleyan University, Salina.
L. C. Hodson, 1905, University of Kansas..... Lawrence.
B. C. Hubbell, 1905..... Concordia.
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Thos. M. Iden, 1897, State Normal School..... Emporia.
F. B. Isely, B. S., 1902, high school..... Wichita.
John J. Jewett, 1902..... Sawtelle, Cal.
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A. W. Jones, B. S., 1894, Kansas Wesleyan University.. Salina.
Hugo Kahl, 1897, Carnegie Museum..... Pittsburg, Pa.
George F. Kay, 1904, State University..... Lawrence.
W. H. Keller, 1898, Atchison county high school..... Effingham.
Harry L. Kent, 1904, high school..... Hays City.
John H. Klopfer, 1904..... Topeka.
E. B. Knerr, Sc. D., 1889..... Atchison.
Rev. James G. Knotter, 1903..... Dexter.
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B. E. Lewis, 1904, city schools..... Eureka.
C. H. Lyon, 1900, high school..... Emporia.
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R. Matthews, D. D. S., 1898..... Wichita.
Walter E. Matthewson, 1903, Kansas Agr. College... Manhattan.
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C. E. McClung, 1903, University of Kansas..... Lawrence.
Elmer V. McCollum, 1902, University of Kansas..... Lawrence.
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D. F. McFarland, 1903, University of Kansas..... Lawrence.
J. M. McWharf, M. D., 1902..... Ottawa.
W. G. Medcraft, 1904, Kansas Wesleyan University.. Salina.
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H. L. Miller, 1904, high school..... Topeka.

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Travis Morse, 1903 ..... Iola.
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A. M. Nissen, A. M., 1888, high school ..... Wetmore.
Henry N. Olson, 1905, Bethany College ..... Lindsborg.
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W. K. Palmer, M. E., 1897, consulting engineer ..... Kansas City, Mo.
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Norman Plass, D.D., 1902, president Washburn College, Topeka.
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W. S. Prout, 1904 ..... Topeka.
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W. B. Robertson, 1905, student ..... Lawrence.
A. P. Ruediger, 1905 ..... Lawrence.
Lumina C. Riddle, M. S., 1902 ..... Columbus, Ohio.
Arthur Ringer, 1902, Atchison county high school ..... Effingham.
W. G. Russell, 1905 ..... Russell.
Richard Scammon, 1905, student ..... Lawrence.
D. C. Schaffner, 1903, College of Emporia ..... Emporia.
J. H. Schaffner, A.M., M.S., 1902, Ohio State University, Columbus, Ohio.
Theo. H. Scheffer, 1903, Kansas Agricultural College, Manhattan.
Eva Schley, 1903, high school ..... Topeka.
Aaron Schuyler, 1904, Kansas Wesleyan University ... Salina.
C. H. Shattuck, 1899, Washburn College ..... Topeka.
Roscoe H. Shaw, 1904, University of Nebraska ..... Lincoln, Neb.
J. L. Shearer, 1902, public schools ..... Halstead.
E. T. Shelley, M. D., 1892 ..... Atchison.
R. S. Sherwin, 1904 ..... Norman, Okla.
Claude J. Shirk, 1905, teacher of science ..... McPherson.
J. A. G. Shirk, 1904, University of Kansas ..... Lawrence.
Paul L. Shuey, 1905, University of Kansas ..... Lawrence.
Ralph C. Shuey, 1905, University of Kansas ..... Lawrence.
Eugene G. Smyth, 1901 ..... Topeka.
Wesley N. Speckman, Ph. D., 1903, Kan. Wesl. Univ., Salina.
B. T. Stauber, D. D., 1903 ..... Salina.
S. G. Stewart, M. D., 1904 ..... Topeka.
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Norman Triplett, 1905, State Normal School ..... Emporia.
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P. F. Walker, 1905, University of Kansas..... Lawrence.
J. D. Walters, M. S., 1894, Kansas Agr. College .... Manhattan.
Howard R. Watkins, 1905, Kansas Agr. College..... Manhattan.
C. D. Weaver, M. D., 1902 ..... McPherson.
Ella Weeks, 1903, Kansas Agricultural College..... Manhattan.
J. E. Welin, 1899, Bethany College ..... Lindsborg.
W. B. Wilson, 1903, Ottawa University..... Ottawa.
E. M. Williams, 1904 ..... Chicago, Ill.
L. B. Wishard, 1903, high school..... Iola.
C. H. Withington, 1903, Kansas Agricultural College, Manhattan.
Heman A. Wood, 1905, Kansas Agricultural College.. Manhattan.
H. I. Woods, M. S., 1902, Washburn College..... Topeka.
L. C. Wooster, 1897, State Normal School ..... Emporia.
J. A. Yates, M. S., 1898, Ottawa University..... Ottawa.

Total number of members, January 10, 1906, 204.

SECRETARY'S REPORT, 1905.

THE present secretary began his duties about the 10th of January. At that time the nineteenth volume of the Transactions was in the hands of the state printer, and one of the first tasks devolved on the new secretary was to see that the promises of an early issue of the forthcoming volume were duly fulfilled. It soon became apparent that the state printer was not bound by an understanding he had with Professor Grimsley, either because the latter did not make the plan sufficiently definite, or because the former had a change of heart after it was settled that he would go out of office in June. At any rate we could not get the extra copies of papers which the Academy had voted, and the best that could be done was to have fifty extra copies of each signature of the Transactions printed. These were divided up and sent to the authors as a partial remedy for the failure.

The rush of legislative printing delayed the completion of our volume till May, and it was gratifying to note, when it did come out, that it was the largest and one of the best yet sent forth by the Academy.

The Transactions were distributed according to vote of the Academy, giving to each member a copy, and an extra copy was sent to writers of papers.

The usual distribution to exchanges was made, and copies sent to state officials and to prominent newspapers. Members of the legislature were supplied on application, but other applicants had to be informed that our Transactions were on sale at list prices.

The exchange list is much as it has been for some years, and it may be very profitably revised and enlarged. It is through this that our library obtains its growth, and will become, if properly managed, a very unique and valuable collection of books.

THE MUSEUM.

While the last legislature was in session, an invitation was sent out by the secretary for members and others to visit the museum, then just installed in its permanent quarters.

It is believed that this had a favorable influence in making known the work of the Academy and in securing legislative provision for its support. We are by law a "coordinate department

of the State Board of Agriculture," and there is no doubt we shall receive all the recognition we deserve. We have a field of activity of our own, which supplements the agricultural, the educational, the mechanical and the commercial work of the state, and it is for us to take possession of our province.

In its enlargement our museum has happily taken the form of an exhibit of the economic mineral resources of the state, and this, with proper care and growth, may become one of the most interesting and useful collections in the state-house. Our present display is the outcome of the Louisiana Purchase Exposition, at St. Louis, and the near approach of the commemoration of the semicentennial of Kansas is an opportunity this Academy should not neglect of strengthening itself and doing its share in the upbuilding of our commonwealth. It will be very appropriate at this meeting for the Academy to put itself on record as a promoter of this worthy enterprise. The mineral resources of Kansas are only beginning to be known, and promise to add to our wealth an equal quota with the agricultural products. The total value of our coal, of our petroleum, our clays, cements, and plaster, of our salt, of our glass sand, and many other minerals, represents a fortune, compared with which the wealth of a modern Crœsus appears insignificant.

LIBRARY.

Reference has already been made to our books, and in considering a library, its quality is quite as important as its size. We are constantly receiving the transactions of scientific bodies from various parts of the earth. We also get various government publications from Washington, and have had each year, for some time, several hundred volumes of these publications neatly bound. Our catalogue at this date gives only the titles of these volumes, grouped under names of the countries from which they come. We need very much a catalogue arranged according to modern library methods, which will make it possible to use conveniently the many valuable books in our collection. All the leading European languages are represented, and your secretary will need clerical assistance to bring the library into proper shape.

We have been loaning books to members with much advantage, no doubt, but this practice requires some rules as to the time such loaned books may be kept, or the library will suffer loss. I recommend a committee to formulate such rules as may seem best to govern the loaning of books.

The Transactions are the chief asset of the library, and owing to

irregularities in the number published of each volume, it has come to pass that we can no longer furnish complete sets. A few years ago a reprint was made of the first three volumes, and now a similar reprint is needed of volumes IV, V, VI, and VII. With this provision we can furnish as many as 100 complete sets of our Transactions, and with these can secure valuable exchanges for our library.

The committee on purchase of books has not yet reported to me any action, although their attention has been called to it several times. The money now in the treasury would go far toward paying for reprints of the four volumes mentioned above, and they would be equivalent to a library fund that will in time bring back to the treasury several times the sum invested.

The State Printing Board honored our requisition for binding 500 volumes, and about one-half that number are now completed and on our shelves.

ACCESSIONS.

There have been added to the library, since January 10, 1905, 70 bound volumes and about 600 unbound volumes and pamphlets. These are outside of our regular exchanges, and the bound volumes are mainly from the Smithsonian Institution and other departments at Washington.

The geological and agricultural bureaus are especially prolific, and some of their publications are of great value. We obtain, also, many costly publications from St. Petersburg, and it would be convenient for helping reference to such books to have on our tables lexicons of the languages in which our books are printed.

J. T. LOVEWELL, *Secretary.*

DECEMBER 1, 1905.

MINUTES.

Thirty-eighth Annual Meeting, Kansas Academy of Science, December 1 and 2, 1905.

LAWRENCE, KAN., December 1, 1905.

PURSUANT to call of the executive committee, the thirty-eighth meeting of the Kansas Academy of Science was opened in the lecture-room of Snow hall at nine A. M., with the president, L. C. Wooster, in the chair. There was an attendance of about fifty members, and the president announced the following committees:

On resolutions: Messrs. Mead, Willard, and Miss Meeker.

On necrology: Messrs. Knaus, Miller, and Cooper.

On membership: Messrs. Bushong, Tucker, and Harshbarger.

On nominations: Messrs. Stevens, Scheffer, and Iden.

On the press: Messrs. Sayre and Knaus.

The secretary's report was read and accepted. On motion, certain recommendations of this report were referred to a committee, and the chair named Messrs. Willard and Bushong as this committee.

The Academy next listened to the reading of papers in the following order:

1. A new repetition of the Foucault pendulum experiment, J. T. Lovewell.
2. The genesis of gold in mineral veins and placers, J. T. Lovewell.
3. Some recent high-efficiency lamps, L. H. Freeman.
4. Is the rainfall of Kansas increasing? F. H. Snow.
5. The University of Kansas expedition into the John Day region of Oregon, C. E. McClung.

Professor Sayre, on behalf of the local committee, announced that the afternoon meetings of the Academy would be in two sections, which is necessary in order to complete the reading of the papers that are on the program.

President Wooster ruled that the vice-presidents will be chairmen at these meetings of the sections, which will be designated as section A and section B, respectively.

Reading of papers resumed.

6. The variation of latitude, E. Miller.

7. Examination of coal-dust after explosion in mines (read by title, in absence of author), E. Bartow.

The committee on nomination, reported the following names for membership:

Frank G. Agrelius, teacher	Lawrence.
Carol D. Armstrong, M. D.	Salina.
Charles I. Corp, University of Kansas	Lawrence.
E. G. Corwine, student	Mulvane.
Emil O. Deere, Bethany College	Lindsborg.
E. X. H. Dunmire, University of Kansas	Lawrence.
Harry Eagle, student	Topeka.
Thomas B. Ford, University of Kansas	Lawrence.
Frank Hartman, student	Kansas City, Kan.
Francis C. Herr, physician	Ottawa.
R. W. Coppedge, high school	Topeka.
Lillian E. Fowler, Ottawa University	Ottawa.
L. C. Hodson, University of Kansas	Lawrence.
B. C. Hubbell, secretary Casine Soap Company	Concordia.
C. H. Lyon, high school	Emporia.
Henry N. Olson, Bethany College	Lindsborg.
W. B. Robertson, student	Lawrence.
A. P. Ruediger	Lawrence.
Richard Scammon, student	Lawrence.
Claude J. Shirk, teacher	McPherson.
Paul L. Shuey, University of Kansas	Lawrence.
Ralph C. Shuey, University of Kansas	Lawrence.
Frank Strong, chancellor of University	Lawrence.
Norman Triplett, State Normal School	Emporia.
P. F. Walker, University of Kansas	Lawrence.
Howard R. Watkins, Kansas Agricultural College,	Manhattan.
Heman A. Wood, Kansas Agricultural College	Manhattan.

On motion, the vote of the Academy was cast by the secretary for the election as members of the persons named in the report.

Adjourned, to meet in sections at two o'clock P. M.

SECTION A.

F. W. Bushong, president; L. E. Sayre, secretary.

8. The disintegration of cement and plaster walls, E. H. S. Bailey and S. G. Stromquist.

9. The fluorescence of a solution of quinine salts, H. P. Cady.

10. Some properties of the alloys of the ferro-magnetic metals, considered from the standpoint of Osmond's allotropic theory, Bruce V. Hill.

11. Kansas petroleum (third article, read by title), E. Bartow.

12. Something about mineralogy, J. C. Cooper.

13 Note on certain formulas for the design of reenforced concrete beams, Albert K. Hubbard.

14. On the substituted ureas, F. B. Dains.

15. Chemical processes for the detection of adulterants in organic substances and medicinal chemicals, L. E. Sayre.

16. An investigation of Kansas mine water (by title), E. H. S. Bailey.

17. Chemical reactions in benzene (by title), H. C. Allen.

SECTION B.

W. A. Harshbarger, president; D. F. McFarland, secretary.

18. A chemical study of the lime and sulfur dip, Roscoe H. Shaw.

19. The Loup Fork Miocene of northwestern Kansas, Charles H. Sternberg.

20. The reaction of animal cells to chemical stimuli, F. H. Hartman.

21. Test for cyanide (read by title), H. P. Cady.

22. Note on use of mercurous sulfate in standard cells (by title), H. P. Cady.

23. A mineral found in Topeka, J. T. Lovewell.

24. Additional observations on the geology of Kansas, L. C. Wooster.

25. Notes on Coleoptera, W. Knaus.

26. Some mastodon and mammoth remains found in Buffalo, Kan., M. E. Canty.

27. Notes on the flora of the Rosebud Indian reservation, South Dakota (by title), Albert B. Reagan.

28. Hygroscopic structures in the distribution of pollen grains and spores (illustrated), M. A. Barber.

29. Secondary increase in thickness of smilax (illustrated), W. C. Stevens.

30. Nutrition of developing spores in ferns (illustrated), W. C. Stevens.

31. Dry periods in northeastern Kansas and the relation to water-supplies, W. C. Hoad.

32. Collecting insects at night, E. S. Tucker.

33. Transpiration in plants, L. M. Peace.

34. *Melilotus alba* (white clover) (by title), R. W. Coppedge.

35. On Coleoptera of New Mexico—III, W. Knaus.

36. Notes on Cicindelidæ—II, Eugene G. Smyth.

Section adjourned at five o'clock.

At six o'clock the Academy met in the large assembly-room of Snow hall, where a most delightful banquet had been prepared by the faculty of the University, and soon about seventy-five mem-

bers were seated at the long table, and Professor Bailey acted as master of ceremonies.

After justice had been done to the bountiful repast, and toasts were responded by Messrs. Snow, Sayre, Willard, Strong, Lovewell, Mead, Cooper, Miller, Knaus, and others, it was time to go to the lecture-room and resume the

GENERAL SESSION.

The first order was to listen to President Wooster's retiring address. The theme chosen was "The Development of the Sciences in Kansas."

After this address, which was heard with interest, the Academy adjourned, to meet to-morrow at nine o'clock.

GENERAL SESSION, SATURDAY, DECEMBER 2, 1905.

The committee on nominations reported their action as follows:

For president, F. O. Marvin, Lawrence.

First vice-president, B. F. Eyer, Manhattan.

Second vice-president, J. E. Welin, Lindsborg.

Treasurer, Alva J. Smith, Emporia.

Secretary, J. T. Lovewell, Topeka.

On motion of Professor Miller, the rules were suspended, and the president directed to cast the vote of the entire Academy for the candidates named.

On motion, the Academy separated again into sections and proceeded with the reading and discussion of papers.

SECTION A.

37. Natural gas in Lawrence, H. W. Emerson.

38. The Red phalarope, a new bird for Kansas, L. L. Dyche.

39. A simple method of finding the line of intersection of pyramids and planes, Chas. I. Corp.

40. The interpretation of indicator diagrams, Chas. I. Corp.

41. A [illegible] of Hoosier's magnetic alloys of manganese, copper and [illegible], Stan. V. Hill.

42. A [illegible] west of Topeka, Wm. S. Prout.

43. A [illegible] at Mount Vernon (by title), M. L. Wood.

44. [illegible] ornithological collecting expedition of the [illegible] Tex., F. H. Snow.

45. [illegible] ornithological expedition to southeast Ari[illegible]

MUSEUM (looking east).

46. A revised catalogue of the Lepidoptera of Kansas, F. H. Snow.

47. Noise; its relation to health disease, and longevity, J. M. McWharf.

48. History of oil and natural gas development in the middle West (by title), George P. Grimsley.

SECTION B.

49. On Haliptidæ, Dytiscidæ, Gyrinidæ, Hydrophilidæ, Sylphidæ, Elasticidæ and Ptinidæ of Kansas, W. Knaus.

50. On the malaria musquito and the relative number present in the vicinity of Lawrence, S. J. Hunter.

51. Catalogue of the Goss ornithological collection, with original notes and measurements by Col. N. S. Goss (by title), prepared by B. B. Smyth, curator.

52. Comparison of the microscopical structure of stems and roots, C. M. Sterling.

53. Additions to the list of Kansas Coleoptera for 1905, W. Knaus.

54. Notes on the white sheep, L. L. Dyche.

55. A little experiment in flower-making, Grace Meeker.

56. The gas- and oil-engine for commercial purposes, P. F. Walker.

57. A deep well at Emporia, Alva J. Smith.

58. Additions to list of Kansas arachnids, Theo. H. Scheffer.

59. Additions to the list of Kansas Diptera, F. F. Crevecœur.

60. The botanical features of the new United States Pharmacopœia, L. E. Sayre.

61, A revised catalogue of the Lepidoptera of Kansas, F. H. Snow.

The committee on necrology reported that no death of any member during the past year had been brought to their notice.

Professor Bailey and others called attention to the need of a publication committee, who should decide which of the papers read during the session should be printed in the Transactions.

The matter was left in the hands of the executive committee to appoint such a board of critics.

Professor Sayre announced that special privileges would be granted to members of the Academy in visiting the exhibition of Tissot paintings.

The committee on resolutions reported as follows:

The thirty-sixth annual session of the Kansas Academy of Science, now drawing to the close of a most profitable meeting, finds reason for congratulating itself upon the zeal of its members in gaining accessions to the membership list, as well as in the number of papers offered, showing the work in science during the year.

The Academy wishes to record its appreciation of the work done by its officers in arranging for and conducting the various meetings. Especial thanks are due the committee for the rearrangement of the program into sections, and for furnishing to the members appropriate badges.

Our thanks are due to Professor Griffith for special courtesy, making it possible for the members to enjoy the Tissot pictures.

To the members of the Academy in Lawrence, whose guests we have been, we offer hearty thanks for the generous hospitality shown us and our friends, which will make another in the series of "red-letter days" to add to the memories of former years in meetings of the Academy.

J. R. MEAD,
J. T. WILLARD,
GRACE MEEKER,
Committee.

The committee to whom was referred the secretary's report recommend:

1. That in books borrowed from the Academy library, the time limit during which a book may be retained be one month, and that it be the duty of the secretary to notify the holder of the expiration of the time.

2. That volumes IV, V, VI and VII be reprinted as soon as the funds of the Academy permit, and that the matter be referred to the executive committee for action.

3. That we give our hearty indorsement to the project of celebrating the semicentennial of the state in 1911.

J. T. WILLARD,
F. W. BUSHONG,
Committee.

TREASURER'S REPORT.

The treasurer reported as follows:

Balance on hand from last year	$321 23
Receipts since, prior to this meeting	159 00

The treasurer's books were audited and found correct.

On motion of Professor Sayre, the treasurer was directed to make a time deposit to the amount of $250.

The receipts from this meeting are not included in the above report.

The business being completed, the Academy adjourned, to meet at the call of the executive committee.

J. T. LOVEWELL, *Secretary.*

DECEMBER 2, 1905.

PRESIDENT'S ADDRESS AND PAPERS READ

BEFORE THE

KANSAS ACADEMY OF SCIENCE,

AT

LAWRENCE, 1905.

I.—PRESIDENT'S ADDRESS.
II.—CHEMICAL PAPERS.
III.—GEOLOGICAL PAPERS.
IV.—BIOLOGICAL PAPERS.
V.—BOTANICAL PAPERS.
VI.—MATHEMATICAL AND PHYSICAL PAPERS.
VII.—MISCELLANEOUS PAPERS.
VIII.—ANNOUNCEMENTS, ETC.

I.

PRESIDENT'S ADDRESS.

"THE DEVELOPMENT OF THE SCIENCES IN KANSAS."

By LYMAN C. WOOSTER, Ph. D., State Normal School, Emporia.

THE DEVELOPMENT OF THE SCIENCES IN KANSAS.

By LYMAN C. WOOSTER, Ph. D., Emporia.

Presidential address, delivered at Lawrence, December 1, 1905, before the thirty-eighth annual meeting of the Kansas Academy of Science.

IN preparing this address, the speaker has kept constantly in mind the needs and special interests of those who are beginners in scientific work or are actively engaged in exploring fields that are new and difficult. More than thirty years of science work in the schoolroom have fostered within him a most earnest desire to help in all scientific enterprises.

The membership of our Academy of Science has been nearly doubled during the past few years by reason of somewhat urgent efforts on the part of its officers and members. Similar efforts made during the past thirty-seven years of the existence of our organization have been attended with equal success, and so, undoubtedly, like efforts will be made during the future years of its existence.

Why should we attempt to increase the attendance at our meetings? Some of the answers that might be given would undoubtedly be the following:

1. All people should be in some degree naturalists, for they will thus have their hours of happiness largely increased.

2. The state needs more naturalists and scientists, for her industries must always be largely agricultural, horticultural and mining in their character, and the prosperity of farmers, miners and orchardists is in large measure dependent on our knowledge of minerals and of plant and animal friends and foes.

3. The schools of the state are giving a large place each year to nature studies and to natural-science subjects, and the teachers in the public schools must be more largely naturalists and scientists if they do this work successfully.

4. The pupils in the public schools need manuals containing serviceable keys of Kansas plants; Kansas insects; Kansas fish, amphibians, reptiles, birds, and mammals; Kansas crustaceans, mollusks, worms, hydra, sponges, and Protozoa; and Kansas fossils and minerals. These keys and natural histories should be prepared by Kansas naturalists and scientists under the auspices of this Acad-

emy or some similar organization containing men and women of large and varied experience in many fields of natural history.

5. A large membership gives the Academy a larger influence throughout the state and with the members of the state legislature. We are sadly in need of such recognition of the worth of our reports and of our library and museum, that abundant appropriations may be easily forthcoming.

6. The attendance at common meeting-places at stated times of large numbers of men of science would enable the Academy so to divide its work as to make it possible for those engaged in similar lines of investigation to meet in sections, and thus enable naturalists, scientists and philosophers to learn by personal conference what is being done in related lines of research.

7. With many contributors to their pages, the Academy could issue more valuable volumes of proceedings and a series of monographs on special subjects.

These seven reasons why we should continue to work for a larger membership to the Academy could easily be extended to several more, but those named will serve as an introduction to what it is desired to present for the favorable consideration of this audience. It is not intended to discuss the propositions embodied in the reasons just given in the order in which they have been presented, but an effort will be made to discuss them as they find place in the orderly unfolding of the subject of this address: The Development of the Sciences in Kansas.

On September 1, 1868, a number of lovers of nature gathered at what is now Washburn College and organized themselves into the Kansas Natural History Society. The name was well chosen, for its members were truly naturalists, and as such have done work of the highest value for themselves and the state.

If those of our members who have made collections of natural-history specimens and data will remember the experiences of collecting trips, or those attending investigations in the laboratory, they must declare that this work has brought more hours of happiness than almost any other that has engaged both hands and minds.

The speaker's own most persistent work as a naturalist has been done in collecting fossils, though insects, birds and plants have been collected with almost equal pleasure.

There is great delight in going through one's collections to feast one's eyes on some rare forms possessed by few others. Each time the hand rests on the specimen there is experienced anew the wild delight that was present when there was first found a specimen of

Eurypterus pachychirus, *Petalodus alleghaniensis*, or *Hydreionocrinus kansasensis*. Each detail of each great find is indelibly stamped on the memory. The only moments of regret come when it is remembered how the unfortunate individual who has been so indiscreet as to ask about the collections has been bored as the rare things have been brought out, their possessor forgetting that the poor victim knew little or nothing of what he was pleased to show him, and that he cared even less.

As a teacher of the sciences anxious to discover the best ways of presenting the subjects that belong to his department, the speaker has asked himself and others, Why do naturalists value their collections so highly, and why were most scientists first naturalists?

A glance through the reports of this Academy would make one marvel at the amount of space taken by lists of species contributed by its members, were it not known by personal experience that naturalists prize their collections even more than they do the knowledge that this or that species of plant or animal is a friend or a foe to the farmer, orchardist, or gardener.

In the first volume of proceedings issued by this Academy there is found a catalogue of plants, by J. H. Carruth, with additions by F. H. Snow and E. Hall; a catalogue of birds, by F. H. Snow; and a collection of facts on the climate of Kansas, by F. H. Snow. The lists show that great care had been taken to make them as complete as possible. They occupy more than half of the space of the volume, and must have been very helpful to other naturalists. The succeeding eighteen volumes are almost equally rich in lists of species—in all, more than ninety different lists. Of these, flowering plants furnish nearly one-third of the list, and, in the order named, Coleoptera, birds, minerals, fossils, Lepidoptera and some twelve or thirteen other groups the remainder.

To these lists of species should be added numerous lists of facts of observation and experiment. These comprise numerous references to work done in chemistry, physics, meteorology, mathematics, field geology, astronomy, psychology, and philosophy.

To show still further the intense interest of naturalists in collecting, a few members of the Academy have been asked to give, for use in this address, the number of species represented in their private collections.

Mr. Warren Knaus, of McPherson, reports that he has collected or obtained by exchange, since 1880, 5512 species of Coleoptera, distributed among 38 families.

Prof. Alfred W. Jones, of Salina, says that during the past ten

years he has collected 250 species of fossil plants from the Dakota sandstone; 30 invertebrate fossils from the Mentor Beds, of which 8 were new to science; and 300 species of marine and fresh-water shells.

Mr. B. B. Smyth writes me that the state collections under his charge at Topeka contain the following numbers of species and specimens:

	Species.	*Specimens.*
Birds, Goss collection	768	1,680
Birds, state collection	313	412
Mammals	34	40
Fishes, Popenoe and Smyth	78	80
Reptiles, Popenoe and Smyth	33	42
Insects, Snow and Popenoe	889	3,713
Herbarium, Smyth	1,860	5,600
Conchological collection, Quintard and Smyth	640	5,250
Totals	4,310	16,817

Mr. F. F. Crevecœur, of Onaga, Kan., reports the following very interesting miscellaneous collection:

	Species.	*Specimens.*
Birds	150	150
Mammals	9	11
Snakes	4	12
Lizards	4	15
Frogs	4	6
Fishes	2	4
Fossils	46	150
Plants	350	500
Archæology	2	3
Birds' eggs	54	300
Crustacea	15	30
Arachnida	21	50
Neuroptera	38	70
Orthoptera	47	90
Diptera	137	275
Hemiptera	383	750
Hymenoptera	506	1,000
Lepidoptera	630	1,260
Coleoptera	4,100	9,450
Totals	6,502	14,126

Prof. Theo. H. Scheffer, of the State Agricultural College, Manhattan, one of our authorities on spiders, reports 160 species in our state, 4 or 8 species of daddy-long-legs, and 1 species of scorpion.

Our most inveterate collector of vertebrate fossils is Mr. Chas. H. Sternberg, of Lawrence. His more than thirty years of experience in digging and restoring skeletons is probably unequaled in the United States.

Largely while in company with Dr. F. H. Snow, the following collection of insects was made by Eugene Smyth, a young man only nineteen years old:

	Species.	*Specimens.*
Diptera	80	230
Hymenoptera	148	380
Neuroptera	28	90
Orthoptera	75	215
Lepidoptera	122	350
Hemiptera	84	208
Coleoptera	2,196	17,678
Totals	2,733	19,151

Prof. F. B. Isely, of the Wichita high school, has in his collection 127 species of Kansas Orthoptera, as well as quite a number of species representing the other orders of insects.

But the monumental work of Dr. F. H. Snow, the oldest in membership and the most persistent collector of this Academy, is probably without an equal in the entire western hemisphere, if not in the whole world, when we consider the personal character of this work. Of insects, Doctor Snow reports:

	Species.	*Specimens.*
Coleoptera	9,060	63,000
Lepidoptera	3,750	10,000
Hymenoptera	2,050	10,500
Diptera	3,340	28,000
Orthoptera	300	1,500
Neuroptera	200	1,000
Hemiptera	500	5,000
Kansas spiders	55	500
Myriapods	45	250
Miscellaneous	200	1,000
Totals	19,500	120,900
Collected in 1904-'05	1,500	50,000
Making a grand total of	21,000	170,900

The account of Doctor Snow's work as a naturalist is still incomplete, for, in addition to his collection of insects, should be counted his early work on plants, his collection of meteorites, his list of Kansas birds, his accumulation of data bearing on Kansas weather, and his boxes of fossils, that he has been too modest to enumerate.

It was the hope of the writer to be able to give several other lists of collections made by members of this Academy, but the data were not received in time for this paper.

Your speaker's own craze for collecting has led him to load his cabinets with fossils; and he is very proud of the fact that he has collected fossil invertebrates and vertebrates from Massachusetts

to California, and in every rock group from the Potsdam sandstone to the Tertiary—in all, 700 or 800 species of fossils and 200 or 300 species of rocks and minerals.

The search for natural-history specimens is but one of the many forms of the collecting activity. As the speaker observed in a paper read at the Manhattan meeting of this Academy, the love of collecting is well-nigh universal, and the usefulness of the thing collected has little influence with the collector. To get something some one else has not, or something that is handsomer than that possessed by another, is balm to the feelings, and is inherent in all life tendencies, whether of man or of the lower organisms.

Modern psychology teaches that the mainspring of the will lies in the feelings and emotions, and not in the intellect, as was once believed. We do what we desire, not what the intellect advises. The student of social ethics has long since learned that the feelings aroused by possession and by rivalry are most potent in determining conduct. This is explained by the scientist who has formulated theories concerning heredity, by affirming that the feelings aroused by possession and rivalry are racial in their character, and are, therefore, inherited, subconscious tendencies in the individual; and that this is why they are so powerful in determining what we shall or shall not do.

To illustrate the power of these subconscious tendencies over the individual who chances to be a naturalist or even a collector of mere curiosities, please try to imagine the correct answers to the following questions: Why should Doctor Horn pay fifty dollars for a single beetle? What was there about a tiger-beetle, the *Amblychila cylindriformis*, that was so valuable or interesting that the museums of Europe and America were anxious to pay Doctor Snow twenty-five dollars a head for them? What is there about a tropical butterfly that should cause collectors to pay $100 or $200 for a single specimen? And why should millions of dollars be invested in canceled postage-stamps by stamp collectors in Europe and America?

Those who have never made a collection, save of silver, gold or paper dollars, who have never turned their racial collecting tendencies in the direction of natural-history specimens, find it nearly impossible to understand why such work as that performed by Doctor Snow has such a powerful attraction for naturalists.

One summer Louis Agassiz, then at the height of his fame as a public lecturer and as professor of zoology at Harvard, spent several weeks collecting in Vermont. A gentleman wishing to see

him inquired of a farmer if he had seen Professor Agassiz that morning. The farmer looked up from his work in surprise, and told the gentleman that Louis Agassiz, the great naturalist, lived at Cambridge, Mass., and that he guessed he would have to go there to find him. "There are no strangers here," the farmer added, "except a crazy old Dutchman who is over in the field yonder catching butterflies and bugs." The thrifty collector of lucre felt no affinity for a "Dutchman" catching insects.

One's ability to appreciate the collections of another seems also to stand in direct ratio to his stock of general information.

Soon after the civil war General Custer led an exploring expedition to the Black Hills. On the invitation of the government, several eminent men of science accompanied the troops. As the Sioux Indians were then very hostile, and the men of science insisted on making side trips for the purpose of collecting natural-history specimens, each scientist was attended by a guard of six soldiers, much to the discomfort of the latter and the inconvenience of the former. One day the most persistent collector escaped from his guard of soldiers and wandered off into the hills, where he was quickly pounced upon by the Sioux. The Indians thrust their hands into his pockets and collecting bag for plunder, and were disgusted to find that they contained plants, fossils, lizards, and other material dear to the heart of a naturalist, but worthless trash to Indians, and were exceedingly puzzled to know what sort of man they had captured. While the savages were discussing the nature of their queer captive, the naturalist saw a rare butterfly, and, forgetful of everything else, started off on a run to effect its capture. He soon returned and proudly exhibited his prize to the Indians. This decided them, and the chief took him gently by the sleeve, led him to a distant ridge, and pointed the way to Custer's camp. The Indians had concluded that the naturalist was insane, and thus, according to their belief, was under the special care of the Great Spirit; otherwise he would have been put to death for invading their country.

The farmer thought that the naturalist was spending his time foolishly; the Indians believed that he was crazy; and it is not sure but that each one of us thinks that the other naturalists would show better sense by collecting our specialty.

I have dwelt thus fully on the deep, unreasoning love with which a collector regards the specimens in his own cabinet, in part to make plain the cause of certain serious mistakes made by naturalists in publishing, as interesting matter to the world in general, the results of

their labors, mistakes which have been repeated by too many science teachers in the classroom.

Lists of plants, insects, and other invertebrates, fish, amphibians, reptiles, birds, and mammals, and detailed sections of geological strata, with lists of the included fossils, are of most interest and value to the one who made the list or section, are of some value to a few specialists, and are of no interest or value to the general reader. In the classroom their value is the same as that of the algebraic quantity, x.

Tons of scientific reports are gathering dust in private and public libraries because 99 readers out of 100 care nothing for them. Lists of species of plants, shells, insects, vertebrates, fossils and minerals are seldom read save by those who desire to make exchanges and who are enthusiastic collectors.

Editors of periodicals intended for the general reader have learned by severe experience what matter pleases their patrons best. I quote the following from an advertising circular issued by the New York *Independent:* "There is a prevalent belief among editors that the average reader hates science and will turn against any journal which attempts to force it down his throat. Nevertheless, we regard it as much our duty to get accurate, authoritative accounts of discoveries in science as it is to record a battle or a royal marriage."

We all know that the *Independent* is right, and the inference is plain. All reports of scientific work to be read by a willing public should be issued in two or three parts. One part might contain the detailed account of experiments performed, uninteresting save to the specialist; the long story of how the observations were made, interesting chiefly to the one who made the observations; and the long lists of names of the specimens collected, valuable mostly in making exchanges and in exciting the envy of other collectors. The second part could be made to show what great and valuable truths had been learned by experimentation or field observation, and how the species collected are related to man's welfare or may be made to contribute to his comfort. A third part should be prepared so as to be of assistance to students and to all others who desire to become naturalists. It should provide some easy method of learning what naturalists have discovered and of getting the scientific names of species of minerals, plants, and animals. To this end, natural-history manuals provided with easily understood keys and glossaries ought to be provided for the use of young naturalists and others little skilled in determining species.

The United States Geological Survey and the state experiment stations, after years of trial, have decided to publish two distinct series of bulletins and monographs, one for specialists, and the other for those interested in the economic work of the survey and the experiment stations in the several states.

While the United States Geological Survey has not as yet seen fit to issue manuals and keys for the ready determination of fossils, minerals, and rocks, the Smithsonian Institution has published in its reports several exceedingly valuable papers containing keys to species which have been very helpful to naturalists. Some of the monographs issued by our Kansas University have served excellently the same purpose.

Our own volume of proceedings is perhaps too small to admit of sharp classification of the papers on the basis of their scientific or economic value; but the lists of species and similar bald enumerations of data might be published separately, in pamphlet form, for the use of specialists.

Your speaker is confident, ladies and gentlemen of the Academy, that we shall receive larger favors from our state legislature when we in our explorations and reports pay more attention to the economic and educational interests of the people of Kansas.

It is a generally accepted truth that naturalists love their work, love its exact methods, love its honest conclusions; that they love their work more than they do their own comfort, more than they do money, and even more than life itself; and that they are seldom guilty of seeking wealth dishonestly. But, from the nature of their inherited subconscious tendencies, naturalists are not altruists. They may love the collections of another, but not the collector.

It is said of one of our most eminent paleontologists that it was never safe to leave him alone with the fossils of another unless they were in drawers and the drawers were locked.

It is certainly right to love our collections, to love our science work; but it is also certain that we need to specialize in the direction of economic value and educational value more than ever before, both because it is right, and because the people, the legislatures and the men of wealth properly refuse money for scientific surveys and scientific institutions unless the work promises to be of direct as well as indirect value to the people at large. The sudden ending of many natural-history surveys at the hands of state legislatures and the difficulty of getting appropriations for most scientific purposes should convince the most inveterate collectors that they

owe something to others as well as to themselves and their collections.

The interests of the schools lie in the same direction as the interests of the people. In days past we have been guilty of thinking that names and classifications and a little morphology, with a modicum of internal structure, were all that any student would care to know about our insects, birds, fossils, and plants. But modern and wiser science teaching demands that pupils get a knowledge of fewer things discovered by others and of more things learned by their own efforts. Knowledge in its dynamic forms, rather than information in a static condition, is what the schools need; hence the text-books must be suggestive, stimulating, and healthful, rather than satisfying. The students must be induced to collect largely and widely, both objects and information, in the field, in the laboratory, and in the library. They need to know a little of how others collect and what they discover—just enough to serve as a stimulus to personal effort. As all know, every day of the student's life must be fruitful of results; days must not pass in fruitless waiting, as is the experience of most naturalists in field and laboratory. Hence, manuals giving the essentials of what is known of each form of life of economic and scientific importance, and of each valuable rock and mineral, keys for the easy identification of every species known in Kansas and suggestions opening the way to valuable lines of inquiry should be accessible to every student and young naturalist in our state, and should be prepared by our most capable men of science.

It is exceedingly unfortunate that many teachers should feel that the items of information contained in physiologies and in old-fashioned natural histories are so important that they should be memorized by their pupils in a purely mechanical way. The results are of course disastrous. No wonder the sciences as taught in many of our high schools and in the grades are disliked by the pupils and are barren of valuable outcome. You who have read examination papers from these schools may perhaps remember some of the wonderful items of misinformation secured by this cramming of valuable facts of experience gathered by another.

A few samples of these misfit groups of unrelated ideas, gathered from sources that shall be nameless, are given as illustrations: "The alligator is the largest insect of North America." "Trypsin changes indigestible food into proteid." "The undigested food goes to the gall-bladder." "Things that are equal to each other

are equal to anything else." "The corniferous limestone is a rock in which fossil corn is found."

Thus far there have been considered the work, responsibilities and duties of the naturalist.

The work of the scientist may properly be considered next, for he follows the naturalist in line of ascent. Natural history becomes natural science when its facts are arranged in an orderly way, or so as to show laws of sequence and underlying principles. The scientist is the one who classifies the facts of observation so as to reveal underlying and related principles, and evolves from the observations and principles his great inductions in the form of theories respecting heredity, cell activities in plants and animals, social economics, the formation of the earth, the constitution of atoms and molecules, the development of the great religions, the origin of plants, animals, and even man, and observed facts in many other lines of research.

Perhaps the wonderful discoveries of truth made by the naturalist-scientist are due in large measure to his remarkably exact classifications of what he has learned by observation, experiment, and reading. While these classifications have yielded rich returns in new truths, both during their construction and in their completed form, they have also served a most important use in directing the investigations of students along fruitful lines of research, and in opening the way for mechanics and inventors to discover new ways in which known forces may be harnessed for the use of man.

While the labors of scientists have brought untold wealth to our industries, they have resulted in mixed blessings to our schools, colleges, and universities.

The scientist so loves his classifications and theories that he is loth to have them materially modified. In the classroom he is very apt to teach that they embody the whole truth and nothing but the truth. As a consequence his pupils become non-receptive to even obvious inductions of new truth.

Luther Burbank has tried to work with university graduates on his world-renowned farms at Santa Rosa and Sebastopol in his plant-breeding experiments, but he has never been able to keep in service a single university student. "Time and again some enthusiastic young fellow," according to W. S. Harwood in "New Creations in Plant Life" (page 138), "would enter upon the work, and, bred to the nomenclature and traditions of the scientists, would at once begin enlightening Mr. Burbank on the best plan to follow in a given instance, forgetting that the silent man patiently listening to him stood at the head of the plant-breeders of the world."

Used properly, the inductions, hypotheses, classifications and theories of the scientist have, as we all know, high educational value. Even the classifications, the most formal of all the work of the scientist, serve an excellent purpose in training students.

Some classifications of ideas or names, such as those found in the dictionaries and cyclopedias, are too simple to be in themselves valuable factors in education, but many of the classifications of animals, plants, minerals and chemicals are so exact in the use of terms, and are so complex in structure, that no student can run down to its appropriate species any specimen in natural history without having previously made a careful study of the form to be classified. The classification of plants in Gray's "Flora" has served as a stimulus to exact observation to a generation of amateur botanists, and so have similar works on vertebrates, birds, and insects.

I do not need to advocate in this presence the cause of the schoolmaster who wishes to make better naturalists and scientists of his pupils; but I fear, sometimes, the most of us need to be urged to make more strenuous efforts in this direction.

With a view to throwing light on the problem of conflicting evidence in court-rooms, Professor Von Liszt, of Berlin, Germany, arranged a quarrel between two of his students, the other twenty-three to have no suspicion that the event was planned.

At the appointed time the quarrel took place, amid tremendous excitement. The professor finally put a stop to it. A week later he lectured on "Evidence," having in the meantime taken the testimony of all those who witnessed the quarrel. Out of the twenty-three well-educated young men, the testimony of no two was exactly alike. No fewer than eight different persons were named as the originator of the fight, in which, actually, but two had been concerned.

The actual firing of a pistol was accurately described by nearly all, but there were four separate versions of the period of the quarrel at which it was fired. The professor's way of quelling the disturbance was described in eight different versions.

"You are like most persons," Professor Von Liszt told his students after reporting the result of this inquiry. "You look, but you do not see. It is not wilful perjurers who impede the course of justice—such persons are few—but careless people like yourselves, who have not trained the eye to report to the brain accurately what it beholds."

Throughout the major portion of the work in botany at the State Normal, students are asked to report what they see and not

what they infer; and yet this rule is unintentionally violated from one to three times, on the average, during each recitation. The students prepare in class detailed descriptions of plants they are studying, and then determine the species by using Gray's "Flora" with its several keys. After each statement of a characteristic in the key the student must pronounce judgment, subject to the criticism of the class and teacher. In this way the students are led not only to observe closely, but also to cultivate the habit of truth-telling, a practice that is exceedingly rare even in brief conversations. The ability to classify a specimen, while in itself a pleasure, also doubles the pleasure of collecting, as all know who have tried it, and greatly increases the range of objects collected.

As before stated, the young naturalists of Kansas sadly lack keys to Kansas specimens, and manuals describing their habits or qualities and economic importance.

Now that the members of this Academy have prepared fairly complete lists of the mamals, birds, reptiles, amphibians, fish, insects and other invertebrates; and of the algæ, fungi, mosses, ferns and flowering plants of Kansas, why, as before suggested, may not this Academy, through special committees, take up the work of preparing natural histories of our animals and plants, each history having its working key to the groups described? Other states have prepared these manuals with predominant economic features, and why may not Kansas? It must be done largely as a work of love; but a wonderful impetus would thus be given to the study of the sciences by the members of this Academy, by the students in the various schools of the state, and by independent workers throughout Kansas.

The third and highest stage in the development of the sciences is that of philosophy, a stage in which we love wisdom for its own sake; where man comes nearest "to thinking the thoughts of God after Him."

When naturalists have collected an abundance of data from the various fields of research among the myriad forms of plant and animal life; when scientists have classified these data in all possible ways, using, for instance, as bases, form, structure, food-getting habits, modes of offense and defense, tendencies to variation, methods of development from the fertilized egg, and the lines of development of the fossil forms dug out of the crust of the earth; and when master scientists shall have taken these classifications of the observed facts, and all the hypotheses and theories of science, and shall have sorted and arranged them with due regard to perspective,

then observation towers will be erected, with tops lifted so far above the bewildering maze of the myriad facts of observation that wide surveys can be made of the dominant truths of God's universe, and heaven-reaching generalizations be made by these master scientists, the true philosophers.

The scientific method of research provides that deduction shall follow, not precede, induction. The visions of truth, the inductions of the scientist-philosophers, help wonderfully in rectifying the work of the systematist, and in showing the naturalist where to observe, where to experiment, and where to collect.

This world does not need more potential energy so much as it needs to know how to transform more of it into useful forms of kinetic energy. So in the formation of the collecting habit, we do not need to urge more people to make collections, but we do need to urge more people to make collections that are valuable, that are useful.

It is to be deplored, for instance, that sane men and women should use valuable time in making collections of buttons, tobacco tags, old shoes, luggage labels, and postage-stamps. Not only do such collectors waste time and effort on their collections, but they also waste energy in the form of hard cash. One European collector was so dominated by the subconscious craze for the possession of rare specimens that he paid $3500 for a poorly printed two-cent stamp issued some years since by Hawaii. A blue stamp issued by a Baltimore postmaster before our general government took charge of the mails sells for $4400, and a one-cent stamp issued by Mauritius in 1847 sold recently for $4840. A Confederate silver dollar is valued at $1500, and one issued by the United States in 1804 is quoted at $1000. This craze for rare things assumes a psuedo-literary phase when collectors offer $8000 for an eighth-century manuscript of Homer's "Iliad," $6450 for the original manuscript of Scott's "Lady of the Lake," and $5250 for the autobiography of Lord Nelson in his own handwriting.

Even natural-history specimens bring absurdly high prices. A Rocky Mountain prospector ate for breakfast six eggs of the Yellow pheasant, and learned ten minutes later, to the discomfort of his digestive organs, that the eggs were worth exactly $100 each. At the time of the tulip craze in Holland, hundred-dollar tulip bulbs were common, and thousand-dollar bulbs not uncommon.

The inductions of the scientist-philosopher also serve a most excellent purpose in correcting the imperfect inductions of the scientist. It is said by G. H. Lewes that Herbert Spencer was

not so much a naturalist or scientist as philosopher; and yet his philosophic grasp of first principles enabled him to correct his friend Huxley, one of the greatest of comparative anatomists, and Hewlings Jackson, a very eminent authority on the pathology of the nervous system, in some questions of fact respecting the comparative anatomy and pathology of the cerebellum.

Spencer had had very limited opportunities for studying the comparative anatomy of animals; but his mind, skilled in philosophy, had seized and retained the essential facts of comparative anatomy as they were presented to him in conversation, in the course of his reading, and in his limited opportunities for observation, and he was thus enabled to correct specialists in their own fields of research.

These remarkable powers of the scientist-philosopher seem at times almost miraculous to those uneducated in scientific methods. He tells the astronomer where to point his instrument to discover a new world. The astronomer obeys and, behold, it is there! Or he tells the chemist that elements of certain atomic weights are needed to fill gaps in the arrangement of the elements according to the periodic law, and the chemist goes to his laboratory and finds them.

In a paper read at the Topeka meeting, objection was made by your speaker to the attempts of certain biologists to make biology a mathematical science, as are physics, chemistry, and astronomy. It was declared in the paper that the mathematician is concerned with the investigation of certain exactly statable postulates or hypotheses; that in biology, on the contrary, the one who uses the method of the mathematician can meet only with wrong results, for life obeys no law other than its own highest good, and this cannot be stated in mathematically exact terms. If the following paragraphs taken from *Science* are true, the above statement seems to need modification.

In *Science* for August 11, 1905, Dr. George Bruce Halstead, of Kenyon College, Gambier, Ohio, discusses the relationship of biology to the new mathematics, the mathematics that has given us the non-Euclidian geometry. I quote from this article. Doctor Halstead says:

"Thus, as the Russian, Alexeieff, has pointed out, after the continuity world scheme had captured the fundamental natural sciences —geometry, mechanics, astronomy, physics, chemistry—had entrenched itself in them and dowered them with generality, uniformity, universality, it went over gradually with scientific investigators,

by habit, so to say, into flesh and blood, and began to penetrate and dominate in physiology, in psychology, in sociology, in biology. . . . So we have the doctrine of a fatalist causality, denial of efficient freedom of the will, belittling of the idealistic endeavor of mankind; hence the pessimistic attitude toward the whole of human existence. . . . But the latest advances in mathematics have rendered unnecessary for biology the wearing of this misfit garment.

"The new mathematics gives now a standpoint for the explanation and treatment of natural phenomena from which the biologic elements need not be suppressed. . . .

"The continuity thought way strives to reduce all phenomena of nature to a general mechanism with fate-determined movement. Just contrary to this, then, is the view that living nature is a rationally correlated realm, in which everything is harmonic, shows adaptation, strives toward perfection."

This discovery that discontinuous variation in biology is in accord with non-Euclidian mathematics relieves students of life problems from the necessity of declaring that the method of studying the life sciences differs widely from the method of studying the mathematical and physical sciences. Darwin tried to conform in his great theory of evolution to the Euclidian continuity theory of mathematics; but the occurrence of sports among plants and animals was fatal to his theory of continuous variation. Darwin's appeal to natural selection to account for wide gaps in the ranks of plant and animal species also failed, for nature could select or reject only what life offered; and life has always persisted in offering those forms of individuals which contain parts possessed by generations of ancestors, and rarely a form with a few parts, found, perhaps, in one individual in a million, never before found on earth. These individuals, those given the new structures, and called sports or mutations, cannot be accounted for by peculiarities of environment, for they and the environment may or may not agree.

Burbank's experiments in plant-breeding have demonstrated that each species is the sum total of all past strains of heredity more or less modified by their interaction. When several species are crossed by pollination, no man knows what may be the outcome. In 100,000 hybrids produced by such crossing, Mr. Burbank found all shades of intermediate characters and many new ones. Selecting from these hundreds of thousands of hybrids those that possessed the qualities he desired, and destroying the rest, Mr.

Burbank has obtained dozens of new forms of fruits, flowers, and forage plants. By hybridization and selection he has been able to change, almost at will, old hereditary instincts and obtain the new ones he desired. Slightly modifying Mr. Burbank's statements respecting his work, he may be said to have found in his ten or fifteen years of wonderful experimentation that the powers possessed by life are the resultant of a mixed heredity from thousands of ancestors, and are, and have been, modified by life to better meet the conditions imposed by environment.

Thus the observations of Burbank as to what constitutes the true mainsprings of variation have still further emancipated life from the Darwinian, materialistic, continuity theory of variation. Thus enthroned in the thoughts of modern scientists, life may now be studied as she manifests herself in myriads of living forms, produced at her own sweet will and varied at pleasure, without invoking any tropism theory to account for her activities, or any Weismann germ plasm theory, or any Mendelian law, to limit her power to transmit her qualities or to vary them in her descendants by her own conscious powers.

Untrammeled by olden-time restrictions, the study of life has progressed by leaps and bounds. The now universally accepted theory of evolution requires that all life activities on earth shall follow one another in a definitely established order: (1) The simple shall precede the complex; (2) the variable shall end in becoming stable; (3) new characters shall be added to the old, and may overshadow and obscure them.

All evolutionists, therefore, may believe that the first activities of life were simple and variable and were consciously performed. By repetition, these in the individual, then as now, became habits. These habits persisted in by individuals for a series of generations became hereditary, subconscious activities, belonging to the species or race. And these, in turn, when they had lost the conscious element, became race instincts.

This generalization made necessary in teaching biology with life as the dominant influence has relieved the classroom of a world of trouble in explaining the relationship of reason to instinct, and of both to subconscious activity.

For example, if we regard nest-building as a subconscious activity all difficulties of explanation vanish. The tendency to build nests is instinctive and hereditary, while the act of building the nest is consciously performed and may be varied at the pleasure of the bird, as observation teaches.

In like manner we may readily explain other activities of the lower animals, such as migration of birds, ascent of rivers by fish to deposit their spawn, and all other provisions for food getting and care of young by both vertebrates and invertebrates.

The origin of instincts from subconscious activities, and these from habits and conscious activities, is a generalization in harmony not only with the doctrine of evolution, but also with the latest teachings of biologic psychology, and it denies in a very pronounced way the prevalent discordant and inharmonious theories of the materialistic biologists and psychologists.

There has been considered here the pleasure attending the work of the naturalist and scientist; that his pleasure is of the earth, earthy, compared with that which comes to the scientist-philosopher when he makes broad surveys of the fields of truth to the farther limits of God's universe.

The pleasures of the naturalist arise from the possession of things that are wonderful or rare. It has its mainsprings in an inherited, subconscious self, and is therefore deeply egoistic. The scientist may take great delight in building his classifications and in being regarded as an authority in his special department of science work; but the naturalist and scientist like best to be alone in their labors, for they demand personal credit for their collections and generalizations. On the other hand, the richer enjoyments of the philosopher arise from companionship in the search for truth, and from the contemplation of that which will bless all mankind in its fruitage.

In conclusion, it is desired to emphasize one or two things said in this address. As an Academy of Science for the state of Kansas, it is believed that it is a duty which this organization owes to the state to assist through its members more young people to become students of science, and to make our observations and experiments as naturalists, our conclusions and classifications as scientists and our broad generalizations as philosophers contribute more largely in the future than in the past to the industrial, social, intellectual and spiritual happiness of the people of our commonwealth. To this end it is hoped that the means suggested for the more ready study of the minerals, plants and animals of our state will soon be provided by the members of this Academy, either as such or as members of the faculties of our higher institutions of learning.

MUSEUM (looking west).

II.

CHEMICAL PAPERS.

"THE REACTION OF ANIMAL CELLS TO CHEMICAL STIMULI."
By FRANK HARTMAN, Kansas City, Kan.

"THE CHEMICAL PROCESSES FOR THE DETECTION OF ORGANIC SUBSTANCES AND MEDICINAL CHEMICALS."
By L. E. SAYRE, University of Kansas, Lawrence.

"A CHEMICAL STUDY OF THE LIME AND SULFUR DIP."
By ROSCOE H. SHAW, University of Nebraska, Lincoln, Neb.

"ON THE DURABILITY OF CEMENT PLASTER."
By E. H. S. BAILEY and W. G. STROMQUIST, University of Kansas, Lawrence.

THE REACTION OF ANIMAL CELLS TO CHEMICAL STIMULI.

By FRANK HARTMAN, Kansas City, Kan.

AS the field of zoology broadens, our increased knowledge of the structure and behavior of animal forms drives us deeper and deeper into perplexing problems of life phenomena. The solution of many of these problems is looked for in the study of the simpler unicellular organisms. The fact that each one of these single-celled creatures is a living unit and performs all of the processes necessary to the maintenance of life makes them an attractive field of investigation.

It is the purpose of this paper to give a review of the work which has been done on the Protozoa in their relation to chemical stimuli and to give a few of the author's experiments on paramœcium. Two different classes of experiments have been carried on—first, the effect of temporary chemical stimulation on the individual animal; and second, the effect of both temporary and continued chemical stimulation on the race. The second class of experiments is manifestly more important.

The effect of chemical stimulation on the individual has been worked out by Jennings on various Protozoa. He has shown that the theory of tropisms, including chemotropism, is false when applied to the ciliates. An attempt was made by earlier investigators to make the reactions of the Protozoa conform to the tropism scheme. Tropism, in this case, chemotropism, is a direct movement or orientation of the animal towards, or away from, a diffusing chemical. In this movement the lines of diffusion bear a direct relation to the position and direction which an animal takes in moving under the influence of a chemical.

There is no doubt about the occurrence of chemotropism among plants, but no animal whose behavior has been carefully studied shows this simple reaction to chemicals. Jennings has demonstrated this fact. Among the protozoans some chemicals stimulate a motor reflex. This reflex action is a sudden backing, followed by a rapid turning of the animal toward a particular side, the one opposite the mouth. When the concentration is great enough, most chemicals start this motor reflex. In a majority of cases this action removes the animal from the source of stimulus, because the

anterior end comes in contact first. But, as Jennings has shown, if the animal is stimulated from behind, from the side or from any localized area the same reflex action takes place, even though it carries the animal into the midst of the chemical.

Some chemicals in weak solution do not stimulate the motor reflex. These are mostly those of an acid reaction. I have experimented with 0.0005 per cent. HCl and 0.00002 per cent. HCl. Several trials were made. The stronger solution did not cause the reflex, but it caused the animal to hesitate before entering. The weaker solution seemed to attract, from the fact that on contact the animal immediately swam into it. Two small drops were placed side by side, one containing the acid solution and the other paramœcium in water. Now, by the aid of a needle or a fine glass rod, the two drops are connected by a narrow neck. In its random course the little animal comes in contact with the diffusing chemical, but instead of backing off immediately it hesitates, perhaps turning toward the aboral side a few times and then entering the drop. This turning toward the aboral side is a normal movement.

After entering the drop the paramœcium darts about, showing signs of stimulation. If the connection between the two drops is small, so that the diffusion of the chemical is slow, the paramœcium, upon starting to reenter the drop of water, is repelled by having its motor reflex stimulated. The result is that the acid drop acts as a trap. If, on the other hand, the connection between the drops is large enough to permit a rapid diffusion of the chemical, instead of always being repelled by the drop of water, the animal often reenters.

The explanation is easily found. In the first instance the diffusion of the chemical is so slight that the two drops remain very different in chemical composition. Now, if an animal attempts to pass back into the drop of water it encounters such a sudden change that its reflex is stimulated, and the animal backs away. In the second instance, where the diffusion of the chemical is rapid, the drops blend into each other, so that the animal encounters no sudden change, and therefore is not repelled. Paramœcium gave a similar reaction to weak acetic acid.

What seems most peculiar in this reaction to acids is that there is no repulsion in entering the acid, but after having entered it the paramœcium is repelled by the water which it has just left. This shows conclusively that weak acid solutions have a positive attraction for paramœcia.

It has been found by other investigators that paramœcia collect in CO_2 which has been placed in the water. The CO_2 renders the

water weakly acid. It has been shown also by them that the metabolism in paramœcium, as in other animal cells, produces CO_2. Let us now place quite a anumber of paramœcia on a slide and watch their movements. In a short time they collect in groups. Is this due to a social instinct? Because paramœcia are attracted by any weak solution which gives an acid reaction, it seems obvious that the congregation of the paramœcia is due to a formation of CO_2 by the metabolism of their bodies.

If we try another class of chemicals, those of an alkaline reaction, we find that they repel.

The effect of immersion in different chemicals varies. In a one-per-cent. solution of NaCl, the organisms revolve about on their short axis and then dart from one part of the drop to the other. This restless activity is followed by short periods of rest.

A one-per-cent. solution of $MgCl_2$ does not produce so great a stimulation. Paramœcia, when immersed in this solution, dart back and forth for a short time, but soon quiet down and act normally. According to Jennings, paramœcia swim about in KI solution for six or seven minutes, giving the characteristic reflex action. This movement is followed by a continuous spinning which lasts for several minutes.

Curare produces a weakening effect after the stimulation, which lasts for about fifteen minutes. In this solution they alternate, running back and forth and spinning about, and finally become extremely quiet.

By these few examples we see how differently some chemicals affect the animal than do others. Some produce a prolonged backward movement, some produce a continued spinning, and others cause various modifications and combinations of these two movements.

Organic chemicals, such as sugars, gelatin, and urea, do not act on the motor reflex, but distend the infusorian and cause protrusions to arise on the exterior of the animal. I have experimented with sugar and gelatin. In connection with experiments with sugar a very interesting thing happened. I had a large ciliate which had been encysted for about nine months. After having tried several different methods to induce it to come out of the cyst, a solution of sugar was used. In about five hours the cyst had burst and the contents had begun to swell. The animal did not resume its active state, but immediately formed a new cyst. The osmotic pressure of the sugar undoubtedly caused the cyst to burst

and the protoplasm to swell. But the sugar solution not being suitable for the animal, it again fortified itself with a new cyst.

The behavior of the paramœcium is not radically different from that of the higher Metazoa, when subjected to chemical solution. The immediate effect is an increased activity. In many cases this is followed by a period of depression. Alcoholic stimulation in man is of the very same nature.

A study of the effect of chemicals on the individual leads one to wonder how chemical stimulation would affect the race. To determine this I have started a series of experiments. So far the chemicals used have been NaCl, $MgCl_2$, and curare. The results up to this time can be only tentative, because some of the experiments have not been carried on long enough.

On September 20 four lines of generation of paramœcia were started. Two lines were from a culture collected at Kansas City and two from a culture collected at Lawrence. In general, I used the methods which Calkins employed in his study of the life, history of paramœcium. For a culture medium I used a tea made by heating a small quantity of hay in ordinary tap water. This was allowed to stand for two or three days to allow bacteria to develop. Each paramœcium culture was kept in a drop of hay tea on an ordinary glass slide. These cultures were kept in a moist chamber to prevent evaporation. The division rate was watched from day to day. At every second or third generation a single individual was removed to a clean slide by the aid of a capillary pipette and new hay tea added. Perhaps the reason why paramœcium thrives so well in hay tea is because the chemicals and food are very much like those found in its natural habitat.

For convenience, we will call the four series of cultures A, B, C, and D. After these cultures had been running for twelve days and twenty-three generations had arisen, two single individuals of A and C were isolated on separate slides. Then a culture medium made up of three parts of hay tea to one part of one-per-cent. NaCl solution was placed on the slide for the animal to live in. Records and observations were made daily. Whenever the cultures were transferred the same amount of NaCl was added to the hay tea. The normal hay series, A and C, were used as check cultures. We will call the corresponding NaCl cultures Ax and Cx. At the end of the first twenty-four hours no division had occurred in either culture. In two days two divisions had occurred in Ax and one in Cx. In five days four generations had been produced in Ax and two in Cx. Cx divided no further, but died at the end of

nine days. Ax continued dividing slowly until the eleventh day, when it ceased dividing, and died on the twenty-second day. During this time the check cultures, A and C, had divided eighteen and six times, respectively.

The check culture C shows a low state of vitality, which accounts for the early death of Cx.

For comparison, we have in the NaCl culture Ax eight generations, as against eighteen generations of the hay check culture A; and in NaCl culture Cx we have two generations, against six of the hay check culture C.

This experiment shows conclusively that continued use of NaCl retards division and finally produces death. It may be safely inferred that the continued use of any chemical produces a decrease in the vitality.

I have also started a series of experiments to determine the effect of the stimulation of an individual on the race. The chemicals employed are one per cent. NaCl, one per cent. $MgCl_2$, and a weak solution of curare. The NaCl and curare cultures are now twenty-five days old and the $MgCl_2$ culture twenty-one days old. The NaCl and curare cultures were taken from the same generation of hay culture C, while the $MgCl_2$ culture is from D. Each culture has been stimulated twice by its respective chemical for periods varying from twenty to twenty-five minutes.

Up to the present time the NaCl and curare cultures show no decided variations from the check cultures. The $MgCl_2$ culture has shown a decided decrease in vitalty. The check culture has passed through seventeen generations while the chemically stimulated one has had only twelve generations. This shows that some chemicals decrease the vitality of the race, even when given in dilute solutions and only for a few minutes at a time.

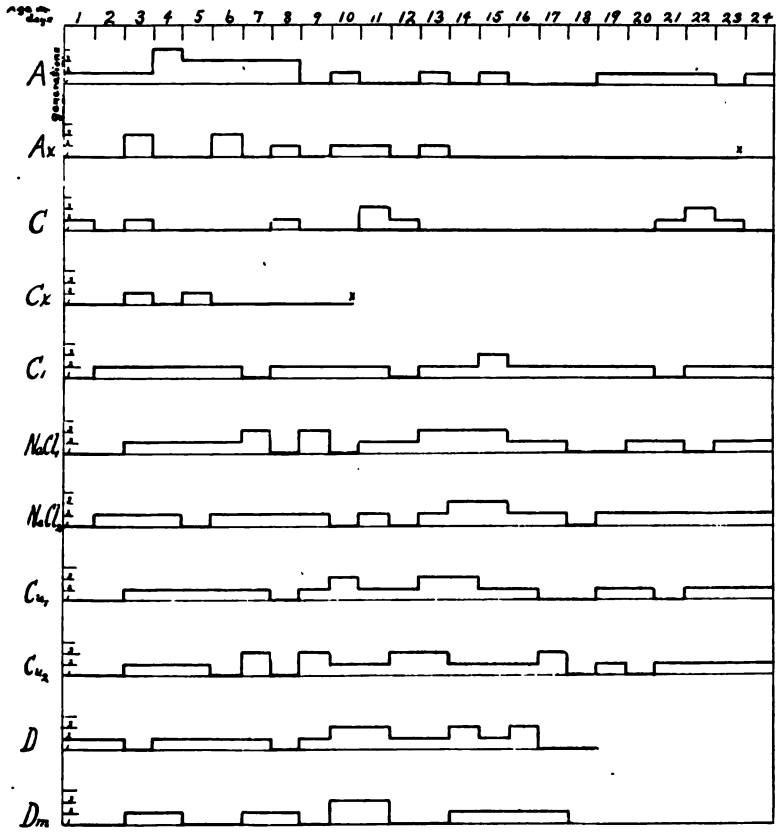
Calkins has succeeded in renewing the vitality of paramœcium by chemical stimulation when in periods of depression. He generally uses extracts from animal tissues, such as the brain, liver, and pancreas. Beef extract has been tested perhaps the most. In my own cultures, when there has been no division for six days, and the animals begin to show signs of dying, by stimulating with weak Liebig's beef extract the cultures have been restored to their normal vitality. Beef extract is not a food but a stimulant. Calkins shows that weak alcohol with continued use increases the division rate and tends to offset periods of depression. Also, that continued use of strychnine slightly increases the division rate and postpones death.

He also thinks that conjugation is a chemical stimulation which takes place by an interchange of nuclear material from individuals that have lived in different environments.

The chemical complex of the nucleus is perhaps determined by generations of varied environment and is influenced indirectly by immediate chemical change. Conjugation is probably in the nature of a chemical stimulus, but stimulation produced by crude chemical stimulation cannot produce the same result.

Loeb's well-known experiments on the unfertilized egg of the sea-urchin seems to give especial emphasis to the theory of chemical stimulation.

There is no doubt that chemical processes occupy an important place in life phenomena. Living organic matter is composed of highly complex organic compounds in a state of unstable equilibrium. Take away life and we place these complex compounds in stable equilibrium. The greater the vitality of an organism the more unstable is the equilibrium. When an organism begins to die it is approaching stable equilibrium. Slight variations in the chemical composition in the fluid supplied for the nourishment of a cell probably tends to maintain this unstable chemical equilibrium for a while; but in time this unstable equilibrium must be reenforced by a delicately complex stimulation from the nucleus of another individual.



Graphic representation of daily division rates of cultures, showing comparison between the chemically stimulated and the normal hay-fed series.

A, Ax, C, Cx, are the "NaCl continued stimulation series." Of these A and C are the check cultures, while Ax and Cx are the cultures stimulated continually with one per cent. NaCl. X marks the day on which death occurred.

C_1 is the check series for $NaCl_1$, $NaCl_2$, Cu_1, and Cu_2. $NaCl_1$ and $NaCl_2$ cultures were stimulated twice with one per cent. NaCl for periods of twenty-five minutes each. Cu_1 and Cu_2 cultures were stimulated twice with a weak solution of curare for periods of twenty minutes each.

D and Dm are the "$MgCl_2$ comparative series." D is the check culture, while Dm has been stimulated once with one per cent. $MgCl_2$ for twenty minutes.

THE CHEMICAL PROCESSES FOR THE DETECTION OF ORGANIC SUBSTANCES AND MEDICINAL CHEMICALS.

By L. E. Sayre, University of Kansas, Lawrence.

THE new (1900) United States Pharmacopœia, which has just been published and officially issued, contains a number of organic compounds which have found their way into medicine and are considered of importance among remedial agents. Among these new agents we find:

Acetone, phenacetin, camphoric acid, trichloracetic acid, ethyl chloride, antipyrine, urethan, benzaldehyde, saccharine, bromoform, chloral formamide, cinaldehyde, cresol, guaiacol, guaiacol carbonate, hexamethylenamine, iodol, salol, safrol, sulfonal, thymol iodide, vanillin, etc.

As it is the province of the pharmacopœia to give approximate tests for identification of the agents made official and to supply methods for the detection of the impurities that may be found in them, it is interesting to note some of these tests.

For this purpose we have selected a few of these organic remedial agents and the tests employed for detection of impurities—those tests that chemists have considered sufficiently reliable to be placed in the hands of any one trained in chemistry. We selected from the list the following organic chemicals and their accompanying tests:

Salol, or Phenyl Salicylate, $C_6H_4(OH)COOC_6H_5$ 1:2.

This substance is apt to contain, as a result of the process of its manufacture, some uncombined phenol, or a minute quantity of salicylic acid. The test for these impurities is as follows:

If 1 gm. of phenyl salicylate be shaken with 50 c.c. of water, the liquid filtered, and 5 drops of ferric chloride t. s.* previously diluted with 20 volumes of water be added, the filtrate should show either no color or at most a trace (limit of uncombined phenol or salicylic acid).

Antipyrine, $C_3HN_2O(CH_3)_2.C_6H_5$.

Is liable to be contaminated or adulterated with acetanilid and acetphenetidin. The tests which apply to these possible admixtures are as follows:

Two [illegible] aqueous solution of antipyrine (1 in 100) mixed

with an equal volume of nitric acid assumes a yellowish color, passing to crimson on warming (distinction from acetanilid and acetphenitidin).

On warming 0.1 gm. of antipyrine with sodium hydroxide t. s., and again warming after the addition of chloroform, the disagreeable odor of phenyl-isocyanide should not be developed (absence of acetanilid).

BENZALDEHYDE, $C_6H_5.COH$.

Has been introduced as an article, artificially produced, to take the place of the natural oil of bitter almonds as a material for flavoring. An aqueous or alcoholic solution of either of these may be used in pastry or other material, giving the peach or almond flavor. The objection to the natural oil of almonds, in some cases, is that it contains as a natural constituent hydrocyanic acid. Benzaldehyde will therefore become a popular substitute, for the better, and to guard against adulteration (or substitution) of benzaldehyde by the oil of bitter almonds, a test for the presence or absence of hydrocyanic acid is introduced, which reads as follows:

If ten drops of benzaldehyde, dissolved in a little alcohol, be shaken with a few drops of a strong solution of sodium hydroxide, then with a little ferrous sulfate t. s., and finally mixed with a slight excess of hydrochloric acid, a blue precipitate should not be produced (absence of hydrocyanic acid).

SACCHARINE, $C_6H_4\left\langle\begin{matrix}SO_2\\CO\end{matrix}\right\rangle NH$ (BENZOSULPHINIDE).

May be adulterated with glucose, with benzoic or salicylic acid. These are tested for as follows:

Glucose.—If 0.2 gm. of benzosulphinide be dissolved in 5 c.c. of potassium hydroxide t. s., the solution should be clear, and not become colored, even on prolonged heating (absence of glucose).

Benzoic acid.—If to a hot aqueous solution of benzosulphinide ferric chloride t. s. be added, drop by drop, no precipitation or violet color should appear (absence of benzoic or salicylic acids).

CRESOL (also known as TRICRESOL), $C_6H_4(CH_3)OH$.

This article is a mixture of the three isomeric cresols obtained from coal-tar, an antiseptic of growing popularity. It should be free from hydrocarbons and phenol. The absence of these is detected in the following way:

Hydrocarbons.—If 1 c.c. of cresol be mixed with 1 c.c. of an aqueous solution of sodium hydroxide (1 in 10), it should be dis-

solved with no appreciable liquid residue (absence of, or limit of, hydrocarbons).

Phenol.—If 1 c.c. of cresol be mixed with 1 c.c. of glycerin, a clear solution should be produced, from which, on the addition of 1 c.c. of water, the cresol should completely separate (absence of, and distinction from, phenol). Phenol forms a perfectly transparent solution with this glycerin and water solvent.

THYMOL IODIDE, $(C_6H_2.CH_3.C_3H_7.OI)_2$.

This article, which has much popularity, is an antiseptic, known by the commercial name of aristol. It should be free from the alkalies, free iodine, and foreign bodies. These are appropriately tested for, but the one test of the pharmacopœia, which will eliminate many of the substitutes that have been marketed for this favorite antiseptic, is the "limit of ash" test, which reads as follows:

If 0.1 gm. of thymol iodide be thoroughly ignited in a porcelain crucible, it should leave not more than 0.003 gm. of residue (limit of ash).

VANILLIN, $(C_6H_3.OH.OCH_3.COH\ 4:3:1)$.

This expensive, fragrant organic compound is very tempting to the unscrupulous merchant as a substance to be very easily adulterated with such a substance as acetanilid; therefore an appropriate test is found in the pharmacopœia to betray the presence of this adulterant, which reads as follows:

On warming 0.1 gm. of vanillin with concentrated alcoholic solution of sodium hydroxide, adding chloroform, and again warming, it should not give an odor of phenyl-isocyanide (absence of acetanilid).

The author of this paper commented upon the various tests mentioned, and not only showed their importance but gave his personal experience in the employment of them.

A CHEMICAL STUDY OF THE LIME AND SULFUR DIP.

By Roscoe H. Shaw, Manhattan.

LIME and sulfur dips were brought to the writer's attention some two years ago by Dr. N. S. Mayo, at that time state veterinarian. The problem to be solved then was the remedying of a turbidity which ensued when the concentrated ooze was diluted with the ordinary hard water of the Western plains. One thing led to another, until the work extended intermittently over a period of about one year. Among the phases of the subject taken up was one concerning the chemical changes taking place in the dip when exposed in open vats. Such exposure is the usual occurrence in practice when two immersions are made with a ten-day period between them. During this interval the vats are sometimes partly covered with boards, but more often are left entirely exposed.

The purpose of this paper is to present some of the results obtained in this phase of the investigation.

The dip used was made according to the Fort Collins formula, as given in Bulletin No. 21 of the Bureau of Animal Industry, Department of Agriculture. According to this formula, lime and sulfur, in the proportion of one to three, are boiled with water. Commercial lime and ordinary flowers of sulfur were employed and distilled water used in diluting.

In order that laboratory conditions should conform as closely as might be with those obtaining on the ranch, miniature vats were constructed of wood, with all cracks and seams made tight with paraffin. The vat containing the dip which is discussed in this paper was of the style known as the swimming vat, a type in common use in western Kansas. It was eight feet long, six inches deep, and five inches wide.

The vat was filled with dip made as before stated, but diluted somewhat more than is called for by the formula. Each morning, at a definite hour, the contents of the vat were mixed and sampled. During the day a crust formed, which was broken up each morning in order to secure something of the effect of the wind on the vats in practical use. Under ordinary conditions the wind also accelerates the evaporation, but in this experiment no attempt was made artificially to produce the result. Another difference was that the vat, being indoors, was not exposed to sudden changes of temperature, such as would occur in practice.

In sampling, small quantities were taken from different parts of the vat; these were well mixed and a subsample taken for analysis. Care was taken to start the determinations immediately after sampling.

The diluted dips are of an orange-red color. On standing exposed to the air an incrustation soon forms, which consists of calcium carbonate and free sulfur. If this incrustation is broken it falls to the bottom of the containing vessel and a fresh incrustation forms. A slight jarring or even a breath of wind is sufficient to break up this crust; so after standing for some time there will be a layer of sediment on the bottom of the vessel as well as a crust on top, both being of the same chemical composition.

Qualitative analysis of the dip showed presence of calcium sulfides, polysulfides, and thiosulfate. At all times hydrogen sulfide was evolved, due probably to the action of the atmospheric carbon dioxide on the sulfide.

If sulfites and sulfates were present they were in such slight amounts as would be negligible. The absence of quantitive amounts of the last two was somewhat surprising, as it is well known that thiosulfates in solution are converted slowly to sulfites and sulfates according to these reactions:

$$CaS_2O_3 = CaSO_3 + S.$$
$$CaSO_3 + O = CaSO_4.$$

If this decomposition and oxidation takes place in the dip at all it takes place very slowly.

To the writer's knowledge there is no method known for separating the polysulfides of calcium. An attempt was made by employing a freezing mixture of snow and calcium chloride and partially freezing the concentrated ooze, as the dip is called before diluting. The chemical composition of the frozen and the unfrozen portions showed, however, that little or no separation was accomplished.

Necessarily, then, the determinations were limited to those of total sulfur, total calcium, and calcium thiosulfate. By subtracting the calcium and sulfur calculated from the percentage of the thiosulfate from the total calcium and sulfur, percentages were obtained which represented, approximately at least, the calcium and sulfur existing in the combined sulfides. In no case in a large number of analyses of dip did this percentage correspond to that of any one of the polysulfides. Usually it fell between the tetrasulfide and pentasulfide, and could always be assigned to a mixture of the mono- and the pentasulfide. This will be spoken of later in the paper.

The specific gravity was determined in each case, both as a factor in itself and as a means for converting volume into weight.

QUANTITATIVE METHODS EMPLOYED.

Determination of Specific Gravity.—The determinations of specific gravity were made by means of a Geissler's pycnometer, with a capacity of about fifty cubic centimeters, and provided with a delicate thermometer.

Determination of Thiosulfate.—In this determination the sulfides of calcium were removed by means of cadmium. Five cubic centimeters of the dip were stirred into about twenty-five cubic centimeters of freshly boiled distilled water to which had been added a quantity of a five-per-cent. solution of cadmium chloride sufficient to completely precipitate the sulfides. The resulting cadmium sulfide settled at once, was quickly filtered off, and left a clear filtrate. This filtrate was titrated with decinormal iodine solution, using freshly prepared starch as indicator.

Determination of Calcium.—Twenty-five cubic centimeters of the dip were pipetted into a 250 cubic centimeter measuring flask and diluted to the mark with freshly boiled distilled water; twenty-five cubic centimeters, representing two and one-half cubic centimeters of the original dip, were immediately pipetted out into a beaker; two cubic centimeters of a saturated solution of potassium hydroxide and an excess of bromine water added. The beaker with contents was then placed on a hot plate and digested at just below the boiling-point to the complete oxidation of the sulfur. After cooling, hydrochloric acid was added to acid reaction and the excess of bromine removed by reheating. Ammonia was added to alkalinity and the calcium precipitated by adding a sufficient quantity of five-per-cent. ammonium oxalate solution. It was found that less trouble from cloudy filtrates was experienced if this as well as the barium sulfate precipitate spoken of in the next paragraph was allowed to settle for twenty-four or thirty-six hours in a warm place. It was then filtered on an ashless paper filter, ignited to the oxide in a muffle furnace, and immediately weighed.

Determination of Total Sulfur.—In the determination of total sulfur the same procedure was followed as for calcium up to the point of precipitation, when to the hot acid solution a sufficient quantity of a ten-per-cent. solution of barium chloride was added; the resulting precipitate of barium sulfate, after standing as mentioned above, was removed by means of a Gooch filter and filter pump, ignited at low redness, and weighed.

Determinations according to the above methods were made daily up to and including the tenth day, then on the thirteenth day, and again on the sixteenth day.

The results of these direct determinations are given in table I. In table II the figures given are calculated from those in table I. From the percentage of calcium thiosulfate the percentage of calcium so combined is calculated. These figures are given in the second column.

TABLE I.

DAY.	Specific gravity.	Thio-sulfate.	Calcium.	Sulfur.
1	1.0264	0.30%	0.72%	2.24%
2	1.0269	.38	.79	2.35
3	1.0273	.69	.83	2.33
4	1.0277	.87	.82	2.34
5	1.0281	.90	.87	2.35
6	1.0282	.93	.82	2.33
7	1.0284	.96	.83	2.35
8	1.0286	1.00	.85	2.36
9	1.0289	1.03	.85	2.35
10	1.0291	1.07	.84	2.35
11*	.....	.....	.....	.....
12*	.....	.....	.....	.....
13	1.0305	1.18	.84	2.35
14*	.....	.....	.....	.....
15*	.....	.....	.....	.....
16	1.0307	1.29	.86	2.36

* Not determined.

TABLE II.

DAY.	Calcium in thiosul-fate.	Calcium in sulfides.	Sulfur in thiosul-fate.	Sulfur in sulfides.	Per cent. calcium and sulfur of thiosul-fate of total cal-cium and sulfur.
1	0.08%	0.64%	0.13%	2.11%	6.93%
2	.10	.69	.16	2.19	8.28
3	.18	.65	.29	2.04	14.87
4	.23	.59	.37	1.97	18.99
5	.24	.63	.38	1.97	19.25
6	.25	.57	.39	1.94	20.32
7	.25	.58	.40	1.95	20.44
8	.26	.59	.42	1.94	20.97
9	.27	.58	.43	1.92	21.88
10	.28	.56	.45	1.91	22.81
11	.....	.....	.....	.....	.....
12	.....	.....	.....	.....	.....
13	.31	.53	.50	1.85	25.39
14	.....	.....	.....	.....	.....
15	.....	.....	.....	.....	.....
16	.34	.52	.54	1.82	27.33

As previously stated, it has been assumed from the absence of appreciable quantities of sulfite and sulfate that the balance of the calcium is combined as sulfides. This figure obtained by subtracting calcium in the thiosulfate from the total calcium as given in the third column of table I.

In the third column, the sulfur calculated from the percentage of calcium thiosulfate is given, and in the fourth column the difference between this last and the total sulfur is given as sulfur in sulfides.

The percentage of calcium and sulfur in calcium thiosulfate to the total calcium and sulfur is given in the fifth column.

The days in the first column of each table, of course, correspond.

There is much difference of opinion among authorities concerning the sulfides of calcium. Contradictory statements may be found regarding even the more common sulfide, the monosulfide, and opinions differ as to whether or not the others have ever been prepared in a pure state. According to Mendeleeff,* in an admixture with calcium thiosulfate, by boiling a solution of lime or calcium monosulfide with sulfur, calcium pentasulfide is formed, according to this reaction:

$$3Ca(OH)_2 + 12S = 2CaS_5 + CaS_2O_3 + 3H_2O.$$

The same authority ignores the existence of any polysulfides between the mono- and the pentasulfide.

According to Dammer,† both the penta- and the tetrasulfide exist, and may be prepared by boiling calcium monosulfide with the proper proportion of sulfur and water. He recognizes two other compounds also—Herschell's crystals, having the formula, $3CaO.CaS_4.12H_2O$, and Bushner's crystals, $4CaO.CaS.18H_2O$, which may be formed under slightly modified conditions.

To quote Watts:‡ "When CaS is boiled with S and H_2O it dissolves, forming an orange-red solution, the quantity of S which goes into solution corresponds with that required to form CaS_4 and CaS_5; if more S is used, it is deposited on cooling the liquid; if less S than S_3 to CaS is used, some of the CaS remains undissolved. Both solutions are decomposed on concentration with precipitation of $Ca(OH)_2$ and S and evolution of H_2S."

It is seen that there are several possible compounds of calcium and sulphur which might be present in the dip. No attempts were made to separate the sulfides other than the single unsuccessful attempt by freezing, and consequently the data given in this

* Mendeleeff's Principles of Chemistry, vol. II, p. 214.
† Dr. O. Dammer, Handbuch der Anorganischen Chemie, II Band Theil, p. 311.
‡ Watts's Dictionary of Chemistry, vol. I, p. 214.

paper throw little light on the manner in which calcium and sulfur are combined as sulfides.

In the course of the investigation, of which this paper records but a part, many dips were analyzed. Every dip, when analyzed, gave percentages of calcium and sulfur combined as sulfides and as calcium thiosulfate. These figures varied somewhat, but could always be assigned to a solution of various mixtures of monosulfide of calcium, one or more of the polysulfides of calcium, and thiosulfate of calcium.

For the sake of simplicity and for comparison, it is assumed that the dip is a solution of a mixture of monosulfide of calcium, pentasulfide of calcium, and calcium thiosulfate, the relative proportions of which may vary, and of course would vary in a dip exposed to the air, if they decompose at different rates. Some illustrations may be given:

$$2CaS.18CaS_5.5CaS_2O_3.$$
$$5CaS.6CaS_5.3CaS_2O_3.$$

It is not believed that so simple a mixture is the true one, but for comparing results in the vat experiment the above possibility is given.

Some interesting facts may be noted by turning to table I. In the first vertical column it will be seen that the specific gravity is constantly and regularly increased. This increase is due, first, obviously to concentration from evaporation of the water; secondly, to the oxidation of the sulfides. In the next column it will be seen that the percentage of the calcium thiosulfate constantly increases, the greatest increase occurring in the first three days of the experiment. The total increase was 0.99 per cent. in the sixteen days, an average of 0.063 per cent. per day. This increase in calcium thiosulfate may be ascribed to two causes: First, to the concentration, as shown in the increase of specific gravity; and second, to the oxidation of polysulfides from the oxygen in the air:

$$CaS_5 + O \quad CaS_2O_3 + S_3.$$

(The rate of evaporation was found in a later experiment for the same vat and same kind of dip to be 40.16 per cent. for sixteen days; so the thiosulfate from this cause alone would have increased from 0.3 per cent. on the first day to about 0.5 per cent. on the sixteenth day.)

In the third column the percentage of total calcium shows a constant and regular increase. There are at least two independent agents acting here: First, concentration acting to increase the per-

centage; and second, the decomposition of the sulfides by atmospheric carbon dioxide throwing out the calcium as calcium carbonate, and thus tending to decrease the percentage.

In the fourth column may be seen the percentages of total sulfur. After the second day this percentage remains practically constant, varying only 0.03 per cent. As with calcium, there are several changes affecting these figures: First, concentration, tending to increase the percentage; second, decomposition of sulfides by carbon dioxide in the air forming, (*a*) in the case of polysulfides, volatile hydrogen sulfide and insoluble sulfur, and, (*b*) in the case of monosulfides, volatile hydrogen sulfide only, tending to decrease the percentage; and third, oxidation to polysulfides and thiosulfates, thereby throwing sulfur out of solution. These three agencies, and perhaps others acting in the same and different directions, produce equilibrium in the percentage.

If there were sulfites or sulfates present, we would expect a further decrease in percentage total sulfur, owing to the throwing of sulfur out of solution according to the reactions,

$$CaS_2O_3 = CaSO_3 + S, \text{ and}$$
$$CaSO_3 + O = CaSO_4.$$

A study of table II will reveal some other interesting facts. The columns representing calcium and sulfur calculated from the percentage of calcium thiosulfate of course show the same rate of increase as the thiosulfate column in table I.

The column giving percentages of calcium in sulfates shows a constant decrease, as would be expected, since the increase of calcium in thiosulfate must have been at the expense of the calcium in the sulfide. The same holds true for the sulfur in sulfides.

On the first day the ratio of calcium in thiosulfate to calcium in sulfides was 0.08 to 0.64, or as 1 to 8; on the sixteenth day the ratio of calcium in thiosulfate to calcium in sulfides had increased to 34 to 52, or more than 5 to 8.

Likewise the ratio on the first day of the sulfur in the thiosulfate to sulfur in the sulfides was 1 to 13, while on the sixteenth day it had increased to nearly 4 to 13. This disagreement between the two ratios would be expected if the explanation regarding the calcium and sulfur in table I be accepted. The ratio of calcium in sulfides to sulfur in sulfides on the first day is 64 to 211, while on the sixteenth day the ratio had changed to 52 to 182, or, in terms of the first, to 64 to 224. This difference in ratio in calcium and

sulfur is easily explained if it be accepted that the dip is a mixtur of two or more sulfides decomposing at different rates.

Assuming, for the sake of comparison, as has been stated before that the dip is a solution of a mixture of monosulfide, pentasul fide, and thiosulfate, then on the first day $2CaS + 7CaS_5 + CaS_2O$ would correspond to the different percentages, while $CaS + 9CaS + 5CaS_2O_3$ would represent the mixture for the percentage given on the sixteenth day.

ON THE DURABILITY OF CEMENT PLASTER.

By E. H. S. BAILEY and W. G. STROMQUIST, University of Kansas, Lawrence.

FORMERLY the only material used for inside plastering was lime mortar, and upon this was spread a skim coat made from plaster of Paris. Since the discovery of extensive beds of gypsite or gypsum dirt, in various localities in Texas, Indian Territory, Kansas, and Wyoming, this material has been heated to drive off nearly all of the water, and is put upon the market under the names of Agatite, Acme, Alabastine, etc., as a substitute for lime mortar. As this crude gypsum occurs in beds where it can be handled by a grader, loaded on wagons, and hauled directly to the mill, the production of this kind of plaster has become an important industry. While the ordinary gypsum rock must be ground before it can be heated in the kettles, this material needs no preliminary treatment.

The composition of the raw gypsite, the finished product and the set plaster is as follows: *

COMPONENT PARTS.	Raw.	Finished.	Set.
	%	%	%
Silica and insoluble residue.....	12.29	14.31	12.03
Iron and aluminum oxids.....	2.27	2.16	1.62
Magnesium carbonate.....	.78	.91	.61
Calcium carbonate.....	8.01	9.42	8.07
Calcium oxid	2.12	1.85	1.89
Calcium sulfate.....	57.95	66.22	59.37
Water	16.07	4.91	16.38
Totals	99.49	99.78	99.97

From an examination of the analyses, it will be seen that the crude material loses all but about five per cent. of its water when "boiled," and when water is added to the "plaster," before spreading on the wall, it retains practically the same amount of water as it lost when heated; and in fact it again becomes gypsum, or $CaSO_4+2H_2O$.

For practical work, the mason mixes with the cement plaster from three to five parts of sand, and a little "retarder" is used to prevent the too rapid setting. This material has been used for plastering walls for the past fifteen years, and, as far as observed, it seems to last as well as lime mortar.

An opportunity to study the disintegration of this plaster under

* University Geological Survey of Kansas, vol. V, p. 163.

peculiar conditions was recently afforded the author. In the Chemistry building at the State University, which was completed in 1900, there is a room which is plastered on the sides, and in which is situated the fan which ventilates the building. On one side this room is partially open to the air, and cold air is drawn over hot steam-pipes in the cold weather as it enters the room. The air is then drawn through the fan into the flues, by which, after passing over other steam-coils, it is distributed throughout the building. The temperature of the air in the fan room varies with that of the outside air, ranging probably in the winter from 40° F. to 72° F.

It was noticed that the plastering on both sides of the room, above a line extending from the floor on the sides nearest the pipes to the ceiling on the opposite side, had become powdery, and fallen off. In order, if possible, to find the cause of this, several analyses were made of the hard plaster which was still in place in the wall and of that which had fallen off, with the following results in one case:

Component parts.	Original plaster.	Fallen plaster.
Silica and insoluble residue	74.41%	76.42%
Iron and aluminum oxids	2.45	1.18
Magnesium carbonate	1.64	1.09
Calcium carbonate	3.09	6.18
Calcium sulfate	13.58	12.72
Water	4.75	1.98
Totals	99.92	99.57

Other samples gave:

Water	4.76%	1.57%
Water	4.56	2.05

As the samples are taken from different parts of the wall, they will not agree in composition. An inspection of the analysis, however, shows that in every case the fallen plaster contains less than half as much water as the plaster which is in place on the wall. Comparing this analysis with those previously given, we can also form some estimate of the amount of sand that is used with the original material.

It is generally conceded that the setting of plaster of Paris is due to interlacing of the small crystals of gypsum, which are formed in the moist material, and we are familiar with the fact that if all the water is driven out of the gypsum in heating, the plaster will not readily "set." It is evident, then, that about five per cent. of water is necessary to the stability of the finished wall.

The disintegration of the wall of this room may be accounted for by considering that the cold air, as it is warmed by its passage over the steam-pipes, quickly acquires a greater capacity for taking up moisture, and so it abstracts moisture from the nearest available source, namely, the plaster of the walls; this plaster having lost the water that is necessary to form the crystals of gypsum, falls to pieces just as it would before the blowpipe.

It is a well-known fact that the lime-plastered wall will fall to pieces if kept very damp for considerable time, and this is also true of walls made of cement plaster. There is no record, however, of hot, dry winds tending in any way to injure walls of this material, and it is probable that only under the special conditions mentioned above this disintegration could take place.

III.

GEOLOGICAL PAPERS.

"THE UNIVERSITY OF KANSAS EXPEDITION INTO THE JOHN DAY REGION OF OREGON."

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THE UNIVERSITY OF KANSAS EXPEDITION INTO THE JOHN DAY REGION OF OREGON.

By C. E. McClung, University of Kansas, Lawrence.

THE University of Kansas takes pride in its natural-history museum, the largest of any state institution in the country, and almost annually sends one or more expeditions into the field to add to the collections. These explorations have covered a good part of western North America, but until last summer no Kansas party had visited the extreme northwestern portion of the United States. With a desire to make the material in the museum as representative as possible, the zoology department conducted an exploration through the John Day region of central Oregon in search of mammalian fossils. It has been the custom to record in the Transactions of the Kansas Academy of Science the general nature of the explorations conducted by the museum, and for this reason I thought it desirable to make some mention of the one sent to Oregon.

The party, consisting of Messrs. Martin, Baumgartner, Hoskins, and myself, all of the zoology department, outfitted at La Grande and started west over the Blue mountains on July 1. The collecting ground had not been approached from this direction, and it was hoped that some advantage might accrue from this fact, but experience showed that the limited size of the field placed no premium upon any particular entrance into it. This will be apparent from the description of the region which I will give.

The John Day river has its head waters in the eastern range of the Blue mountains, and in its earlier course traverses a roughly triangular basin bounded by different spurs of these mountains. Within this basin there are three divisions of the river—the north fork, the east fork, and the south fork—which unite together before the stream finally turns north to flow into the Columbia river. It is upon the main river, which, just before joining the north fork, runs north and south, that the principal collecting grounds are found. Through the elevated basin the various branches of the river meander, cutting great canyons down through the Columbian lavas that overspread the whole of this part of Oregon. The entire region is indescribably rough, and when one views the relatively low-lying basin from an elevation it appears as if a veritable carni-

val of chaos had disported itself over the land. Such an assemblage of crags, ridges and mounds it would be hard to imagine. A few level spots are found along the streams, but the valleys are very narrow, and it is with extreme difficulty that roads are made. And even when they are once established there are many chances that they will not endure, for heavy waterspouts rush down the narrow canyons piling up great boulders and excavating deep gorges across and along the passageways. There is as great a fear of these deluges in the mountains of Oregon as there is of cyclones upon the plains of Kansas. It is but a few years since the small town of Heppner lost over 500 lives in one of these visitations. Vegetation is very scanty, and the whole region is bare and uninviting.

Into this arena we penetrated with difficulty, after a long journey over the mountains, and settled down to work on the main river in a locality called Turtle Cove. This is a fairly representative portion of the region, and I will describe it in some detail. Just here the river runs almost due north and south for a distance of about twenty miles, through a valley that will average about five miles in width. The hills rise precipitously on each side to a height of about 1500 feet, and from their bases long, slanting terranes extend in toward the river, which winds in and out at the bases of their interdigitating extremities. As many as twenty-two lava-beds may be seen in the hills, and for most of the distance in Turtle Cove they lie approximately horizontal. The terranes are largely composed of lava fragments, but now and then exposures of the John Day formation may be seen lifting themselves into prominence against the darker colored background.

Merriam makes three divisions of the John Day deposits, the lower, middle, and upper, and all of these may be found in Turtle Cove. The lower offers no attractions to the paleontologist, for animal remains have not been found in it, but the peculiar rounded hills into which it forms on exposure make a most striking landscape. Almost all colors of the rainbow may be seen, but the prevailing ones are chocolate red and pea-green. Frequently the dark red mounds are banded with undulating stripes of white, which produces a most bizarre effect. The shades of color vary with the direction of the light, but always have a soft effect. On close inspection the mounds are found to be covered with about six inches of loose soil, cracked into small bits, and it is to this condition that the varying shades of [illegible] are due. Underneath their superficial [illegible] [illegible]tut-

ing the mound is to be found. It is rarely that the lower John Day is to be seen lying underneath the upper layers; more commonly the area occupied by this formation is an exposed valley whose floor is covered by ascending series of these mounds which finally abut against the lava hills.

The middle and upper John Day series resemble each other and differ materially from the lower. They occur in steep cliffs of ashy gray or bright green color, and weather into vertical columns which rest upon harder layers, usually of white or pink, that extend approximately horizontally through the face of the exposure. The whole mass of material is cracked and seamed, and consists of hardened nodules, between which is a softer matrix of the same sort of material. When the irregular hardened masses are exposed on all sides they slake off in concentric layers, which break down and finally leave only scattered fragments of flint-like hardness. These small pieces of hard substance lie upon all surfaces where they can lodge and make the footing of one who climbs upon the cliffs very uncertain. Such exposures occur only occasionally, and there would seem to be no continuous formation over the whole basin. Whether there ever was such a one is very uncertain, but if this was the case then there must have been very extensive weathering and erosion before the Tertiary lava flows buried the region.

The individual exposures of the middle and upper John Day are from 100 to 500 feet high, and in the search for specimens it is necessary to crawl over the surface of these almost vertical cliffs and to look very carefully for bone fragments. Compared with many other collecting grounds in the Miocene there are here comparatively few specimens, but by careful work we were able to find enough to keep us busy most of the time. It is a very difficult matter to remove the bones in good condition because of the lack of homogeneity in the matrix. On digging into the cliff after a specimen it will be found that for a part of the distance the bones will lie in the hard nodules, and will then for a while extend along in the seams that are filled with much softer material. For this reason it is impossible to remove any large part of a skeleton in one piece, and the individual bones have to be carefully removed and pasted up in cloth. The bones themselves, however, are in an excellent state of preservation and make beautiful specimens.

Most of the fossils in this region are mammalian, but in some places turtles are numerous. The commoner specimens belong to

the family of the Oredons, which have a considerable range in size. These animals are now entirely extinct and show characters belonging both to deers and pigs. Primitive horses of several genera are common, as are also various camels and rhinoceroses. Primitive pigs, cats and dogs are found here, but we were not fortunate enough to secure many specimens of them. Rodents of various kinds are not uncommon.

There is not a little dispute about the age of the beds and the manner of their deposition, but the consensus of opinion seems to be that they are Miocene lake deposits. From the nature of the beds and the contained fossils, it would appear as though the lake were shallow and subject to frequent filling up with ashy deposits. The character of the material and the condition of the skeletons embedded in it would seem to indicate that the animals had fallen into a muddy place that later had been cracked by drying, and then once more had been subjected to a mud flow that had filled up the earlier cracks. Only a very careful study of the whole region, after the manner of that conducted by Merriam, would make it possible to determine the nature and sequence of the changes that were involved in the laying down of these interesting deposits.

Our party spent the greater part of the summer in the Turtle Cove region and then descended the river into the Haystack Valley locality. A short time was spent here, and then we took our way over the mountains to make the bend of the river where Bridge creek flows into it. In this historical collecting ground we had no success, and were obliged to end up the season with the least successful expenditure of our time. We left the John Day basin on the west side, after having traversed it from one end to the other, and, from the elevated plateau that bounds it, looked back upon the broken and serried ridges through whose valleys we had been wandering. It was a sight to be long remembered, and I believe there are few like it elsewhere. We reached a branch railroad at Shaniko and here shipped the greater portion of our freight. Final disposal of our team and wagon was made at The Dalles, on the main line, and from this time on we were in civilized surroundings to which there attaches no interest.

THE LOUP FORK MIOCENE OF WESTERN KANSAS.

By CHARLES H. STERNBERG, Lawrence.

IT may seem like telling an old story to speak in this Academy of the Upper Miocene formation. However, as the writer made the first large collection of vertebrate fossils in it, and has spent five seasons there, including the one just past, he hopes to give some information of value in connection therewith.

For countless ages animals have lived out their allotted span, have fought the ever-recurring fight for food and life, and they were finally stricken down by their fellow creatures or by the pitiless forces of nature. The same blind forces covered the remains in the ooze of old ocean, the silt of the lake, or backwater from an ancient stream overflowing its flood-plain, covering the bones with loads of sand or mud. In the course of centuries the burial-places are lifted high and dry, and by the denudation of land in excavating some river valley or during the recession of cliffs their bones are exposed. Under the patient skill of the collector they are secured from their resting-places. In the past fifty years many noble skeletons of the animals have been gathered into museums. Men of wealth are collecting the faunæ of many geological horizons, so that it is now possible to get a good idea of the ancient history of animal life on our earth.

It should humble us "lords of creation." Like the older Agassiz, we should uncover our heads when we enter a paleontological museum, for we stand in the presence of the wonderful works of the creator—works which until only recently has man looked upon with intelligent eyes. In July, 1877, the writer was ordered north from Buffalo Park by Prof. E. D. Cope, in search of fossil vertebrates in the valley of the Loup Fork of Nebraska. An old-line hunter, Abernathy by name, chanced to be at Buffalo selling his last lot of buffalo hides. He spoke of a skull of an elephant in a ledge of sandstone above his cabin. Following this information, the writer, with his assistants, Russell T. Hill and Wilbur Brouse, was delighted to find the first Loup Fork vertebrate he ever collected. It was a great land turtle. These rocks are too old for the elephant; the top of the carapace was so exposed as to seem to an ordinary observer like the back of the head of a large beast. This find was on the middle fork of Sappa creek, some fifteen miles above Oberlin, which place then consisted of a store building in which a

general stock of everything needed by the first pioneers of that part of the state were sold. Parts of Decatur and Rawlins counties were explored, and here were discovered the rhinoceros, three-toed horse, and other animals of the Upper Miocene. One thing frequently noted here was the conglomerate of gravel or fine sand bound lightly together with the chalk that had been washed into whiting by the streams that flowed over the Niobrara group of the Cretaceous rocks that lie immediately underneath. Where masses of this material have disintegrated at the foot of some cliff, the resemblance to old, weather-beaten mortar is so great as to attract instant attention. It is pleasant to know that the geologists of Kansas now call these "mortar beds." The resemblance in many instances was real, as the early settlers plastered the inside walls of their sod houses by simply mixing water with it, and laying it on with an ordinary trowel.

The great land turtle discovered on the Sappa was named *Testudo* (*Xerobates*) *orthopygia* by Cope. Here was also found the short-limbed rhinoceros, called at that time *Aphelops fossiger* Cope, the generic name meaning without horns, as they were absent in the female skull Cope described. As the late Dr. J. B. Hatcher found them on the male, he changed the generic name to *Teleoceras*. In 1882, while in the employ of the museum of comparative zoology of Harvard, the writer discovered the famous locality at Long Island, Phillips county. In 1884 he was employed to explore this deposit for Professor Marsh, of the United States Geological Survey, and, with the assistance of J. B. Hatcher, who was at that time an enthusiastic student from Yale, and who made the first collection of his life there, they collected about ten tons of the bones of rhinoceros, representing many individuals. Professor Marsh leased this quarry, and at once it took the name of the Marsh quarry. A narrow ravine cuts through the center of the deposit. The bones lie scattered along either side of the ravine for a quarter of a mile, often in pockets, or pot holes, in the hard sandstone layer. There are two of these layers, about fourteen feet apart. The interspace is filled with beds of fine molding sand, with some whiting, formed by the wash of the underlying chalk, which when these beds were laid down formed the land surface. There are also beds of sand that have been washed clean by some old current in the flood-plain of an ancient river, for the exposed section shows all the different deposits of a river valley. Above the washed sand is a stratum of sand and clay, showing that the muddy backwater had deposited in a quiet place its load. This layer, on exposure, cracks

in all directions, like the mud in the bottom of a puddle after the water has evaporated.

It has always been a problem to account for the great number of animals represented, and the fact that the bones are all scattered. No two bones are in their natural position; all parts of the skeleton are mingled in the greatest confusion. One would of course be forced from his observation of this region to agree with Doctors Matthew and Hatcher as to the fact of the deposition of these bones in the flood-plain of a running stream of water and not in great lakes, as was believed by the older geologists. The only way the writer has been able to account for the intermingling of all the bones of the skeletons on the bottom sandstone layer is, that as this sand when thoroughly saturated with water would become quicksand, the bones, scattered through the fourteen feet above where they now lie, would sink in it until the impenetrable bottom layer was reached. When the land had not been cut by drainage channels one can readily believe that the above idea would account for the mingling together indiscriminately of the bones of the many skeletons. What caused the death of such vast numbers of rhinoceroses in this place is a question not easily answered. The authorities quoted believe that during great floods all the animals in the vicinity sought the highest point they could find to escape death, but at last their efforts were in vain, and they were drowned in the flood that covered every inch of land. After maceration took place the bones might have been scattered by other floods. Another and equally plausible theory of the writer is that the animals were buried beneath a great sand-storm that tore lose the fine sand of the flood-plain and scattered it in suffocating volume over the frightened multitude, which had sought safety or courage by herding together. One can readily agree with the gentlemen referred to, that, during the Upper Miocene time, there were many watercourses separated by slightly elevated divides and broad flood-plains. Possibly here and there were small lakes where the dense vegetation had clogged some sluggish stream. During a rainy season the whole region for many miles might be converted into lakes and the animals driven from their haunts, and, worn out in efforts to escape, would at last succumb to the inevitable. Another thought in this connection is, that the land was not then elevated above the sea-level more than a few hundred feet. Now it is 3000 feet. This would account for the tropical climate, the slow, sluggish streams, bordered everywhere with swamps, filled with rushes

and sponge moss, while in the more solid ground trees and shrubs, like those of the tropics, raised their heads to the sun.

Last season the writer discovered the most complete set of lower jaws of the great inferior tusked mastodon, at the Sternberg quarry. The jaws miss part of the end that are united at the sympathis and prolonged forward into a broad rostrum, into which the inferior tusks are inserted. These tusks are absent in this specimem, though very complete ones have been found that have fallen out of their sockets, and show that they projected eighteen inches from the jaw, the roots reaching back about two feet to the last molar, that in this set had full possession; the other molars had been cast out. The length of the preserved jaws was two feet six and a half inches. Height at condyles, fourteen inches. In the center of the grinding surface of the last molar the height is nine and a half inches. The length of the molar is about seven and a half inches, and three and a half inches wide. The great distinguishing character of this first mastodon lay in the fact that only a narrow strip of enamel covered the inside of the tusk, while in all the descendants the tusks are encircled with enamel.

The dominate life in northwestern Kansas at that time was the rhinoceros, *Teleoceras fossiger*, and the great land turtle, *Testudo* (*Xerobates*) *orthopygia* Cope. As early as 1882 a large collection of these turtles was made in a narrow gulch that had been carved out of the sand by water on Beaver creek, near the old site of a town of that name.

A great deal of labor was required to secure specimens from the Loup Fork sands. The turtle shells were scattered through sand about four feet in thickness along the face of the bluff for 100 feet; about six feet below was the bed-rock, on which were scattered rhinoceros and other bones. The fact that the limbs were present in many cases precludes the possibility of their sinking in quicksand after death, as, in that case, the loose bones of the endoskeleton would have been left behind; for the same reason they could not have been brought to burial by water very long after death.

During Pliocene time, a little later, the great elephant, *Elephas columbi*, ranged in great numbers over the same region. In 1894 the writer discovered a large deposit of these bones, which are preserved in the University of Kansas.

ADDITIONAL OBSERVATIONS ON THE GEOLOGY OF KANSAS.

By LYMAN C. WOOSTER, Ph. D., Emporia.

ILLUSTRATION OF CLASSIFICATION FORM.

Formations.	*Times.*	*Rocks.*
Paleozoic	Eon.	Series.
Carbonic	Era.	System.
Coal Measures or Kansan	Period.	Group.
Upper Coal Measures or Upper Kansan	Epoch.	Stage.
Lower Coal Measures or Lower Kansan	Epoch.	Stage.
Emporia Beds	Hemera.	Beds or substage.

Carboniferous Rock System of the Carbonic Era.

Thickness, 5555 feet. Time, about 2,500,000 years.

The rock groups and the corresponding time periods:

I. Mississippian.
II. Coal Measures, or Kansan.
III. Permian.

I. ROCKS OF THE MISSISSIPPIAN PERIOD.

But one rock stage of the Mississippian period is represented in Kansas, that of the Keokuk epoch.

1.—Strata of the Keokuk Epoch.

The rock beds found in southeastern Kansas. Thickness, about 400 feet.

(1) *Galena (Boone) Beds*, thickness about 400 feet. These consist of layers of bluish limestone. In the upper portion of these beds the limestone has been extensively eaten out, probably by water containing carbon dioxide, and great quantities of chert, lead sulfide and zinc sulfide have been deposited in the cavities. The ores of lead and zinc are extensively mined at Galena, and in the vicinity of Joplin, Mo. The annual output is worth about $10,000,000 for both metals. The ores are smelted at Cherryvale, Iola, Chanute, Neodesha, and Pittsburg. At about the close of this epoch, the Galena beds were raised above the level of the sea and deeply eroded by sub-aerial agencies. The amount of this erosion is unknown. A deep well at Emporia reached the Galena beds of the Mississippian limestone at a depth of 1920 feet. The level of the surface at the mouth of the Emporia well is 1130 feet above the level of the sea; the level at Galena above the same datum plane is 870 feet. The distance from Galena to Emporia in a straight line is 118 miles; therefore the dip of the Galena beds

in the direction of Emporia is about sixteen feet to the mile, assuming that the upper layers of these beds exposed near Columbus would have an elevation of 1100 feet at Galena were they still exposed at that place.

II. ROCKS OF THE COAL MEASURE OR KANSAN PERIOD OF THE CARBONIC ERA.

Thickness, 2780 feet.

1. *Strata of the Lower Coal Measure or Lower Kansan Epoch.*

The rock beds found in eastern Kansas. Thickness, 1440 feet. (The layers are described, beginning with the lowest.)

(1) *Cherokee Beds*, thickness, 450 feet. This formation consists largely of shales, a few thin layers of limestone, several beds of sandstone of various thicknesses, becoming increasingly prominent to the southward, and of seven or more beds of coal. The shales are valuable for brick-making, and the sandstones serve as rich reservoirs of petroleum and natural gas under a belt extending from Paola to Coffeyville and south into Indian Territory. The Weir City coal-bed, situated about 200 feet above the base of the Cherokee beds, yields the coal mined near Pittsburg and probably that mined at Atchison, Leavenworth, and in eastern Indian Territory.

Nearly eighty-five per cent. of the coal, ninety-nine per cent. of the natural gas and ninety-nine per cent. of the petroleum mined in Kansas are obtained from the Cherokee beds. It is estimated that, during 1904, 5,000,000 tons of coal, 7,000,000 barrels of petroleum and an unknown number of billion cubic feet of gas were obtained from these beds; and that from these and the other beds of the Lower Coal Measures were obtained 150,000,000 brick of various kinds and 2,700,000 sacks of cement — all, coal, oil, gas, brick, and cement, worth more than $16,000,000.

The Cherokee beds dip heavily to the southward in southeastern Kansas, increasing to a thickness of more than 9000 feet in eastern Indian Territory. Probably these beds in Indian Territory are the source of the petroleum and natural gas of eastern Kansas. If so, middle Kansas does not overlie this sheet of gas and oil, and, therefore, cannot obtain them from the sandstones of the Cherokee beds.

The Cherokee beds outcrop in Cherokee, Crawford and Bourbon counties, but are penetrated by wells and shafts throughout eastern Kansas, as they dip at a small angle to the westward. Fossils are not abundant in these beds.

(2) *Labette Beds*, 110 feet. These consist of the Fort Scott (Chowego) limestones, twenty-five feet; Labette shales, sixty feet;

and the Pawnee limestone, twenty-five feet. The limestones abound in low anticlines and synclines, and may be easily traced along a line extending from Fort Scott southwestward. Excellent outcrops may be found near Girard, Oswego, and Parsons. The lowest limestone is burned for cement near Fort Scott. Fossils are abundant near the decomposing limestones. The shales thicken to the southward.

(3) *Pleasanton Beds*, 275 feet. These beds include the Bandera (Lower Pleasanton) shales, 100 feet; Parsons (Altamont) limestone, 25 feet, and the Dudley (Upper Pleasanton) shales, 150 feet. The Parsons limestone thins northward and disappears near Pleasanton. Coal is mined at Pleasanton, and some thin layers of sandstone are quarried for flagging on the Marmaton river near Fort Scott. The shales are thicker southward.

(4) *Erie (Bronson) Beds*, 275 feet. These include the Hertha (Bethany Falls) limestone, 15 feet; Ladore (Mound Valley) shale, 100 feet; Mound Valley limestone, 10 feet; Cherryvale (Galesburg) shales, 120 feet, and Independence (Dennis) limestone, 30 feet. The limestones of the Erie beds are best developed to the northeastward, and become thinner bedded and more argillaceous to the southwestward. They contain many fossils. The shales thicken southward, and contain much arenaceous material. They supply excellent clay for vitrified brick, especially at Cherryvale. The Erie beds are a dominant feature of the topography of the country from eastern Miami county to eastern Montgomery county. The shales thin to the northward.

Remarks: In the eastern part of Allen and the western part of Bourbon counties the Erie (Bronson) beds lose in part the shale strata, and the limestones thicken so as locally to form an almost continuous bed of limestone sixty to eighty feet in thickness. This is one of the heaviest of the limestones penetrated in drilling for oil. The Independence limestone of these beds carries a large amount of flint in its lower portion; the upper portion is an oolite which exhibits cross-bedding and false bedding, and attains a thickness in some places of fifteen feet.

(5) *Iola Beds*, thickness 330 feet. These include Chanute (Thayer) shales, 150 feet; Iola (Earlton) limestone, 30 feet; Concreto (Lane) shale, 75 feet; Allen (Stanton, Garnett, Carlyle) limestone, 30 feet; Vilas shale, 45 feet. The shales of the Iola beds are better developed in thickness southward, and the Chanute shales contain much sandstone in the central and southern counties

and in Indian Territory. The sandstone is not well cemented and is everywhere ripple-marked, showing shallow-water deposition. The limestones become thinner-bedded to the southward and are inconspicuous. Thin beds of coal in the shales are mined locally. The Iola beds outcrop along a belt extending southwestward from Kansas City, Mo., by Paola, Iola, and Fredonia, to western Montgomery county. Portland cement is manufactured from shale and limestone at Iola. A warping of the crust of the earth by which the deep seas were shifted from south of Kansas to north of Kansas makes the close of this hemera a proper time for dividing the Coal Measure or Kansan period into Lower and Upper Coal Measures, or Lower and Upper Kansan epochs.

2.—Strata of the Upper Coal Measure or Upper Kansan Epoch.

The rock beds found in eastern Kansas. Thickness, 1340 feet. (The layers are described, beginning with the lowest.)

(6) *Lawrence Beds*, 310 feet. These include Piqua limestone, 50 feet; Le Roy shales (Lawrence shales, north; Chautauqua sandstone, south), 220 feet; Oread limestone, 40 feet. The shales thicken northward, and are replaced by sandstones southward. A few thin beds of coal are mined locally in the shales, and some light flows of natural gas have been obtained from them by wells at Eureka. The important towns located on or near the outcrop of these beds are Troy, Atchison, Leavenworth, Lawrence, Burlington, Toronto, Yates Center, Fall River, Elk Falls, and Sedan.

(7) *Lecompton Beds*, 280 feet. Kanwaka shales (Elgin sandstone, south), 100 feet; Lecompton limestone, 20 feet; Tecumseh shales (Cave Springs sandstone, south), 75 feet; Deer Creek (Strawn) limestone, 25 feet, and Calhoun shales, 60 feet. The shales are thicker north, and quite arenaceous in the southern part of the state. The limestones do not form conspicuous ledges, except on the Kaw river and in the southern counties. Fossils are very abundant, especially in the vicinity of the limestones. The important towns on or near the outcropping of this belt of beds are Lecompton, Lyndon, Hilltop and Virgil in Greenwood county, Elk Falls in Elk, and Elgin in Chautauqua county.

(8) *Eureka Beds*, 230 feet. Hartford (Topeka) limestone, 25 feet; Severy (Osage) shales, 70 feet; Howard limestone, 7 feet; Burlingame shales, 120 feet; and Barclay (Burlingame or Eureka) limestone, 8 feet. All these limestones, especially the last, form prominent escarpments across the state. The eighteen-inch bed of coal mined at Osage City, Burlingame and Scranton lies at the top of the Severy shales, just under the Howard limestone. Several

thin beds of coal are found in the Burlingame shales, and yield some coal by stripping. Hiawatha, Holton, Topeka, Osage City, Eureka, Howard and Cedarvale are situated along this belt of beds. The Burlingame shales eight miles east of Emporia contain so much arenaceous material that in certain portions they are better designated as sandstones. These arenaceous shales are intersected vertically by numerous fissures, many of which show faulting. About thirty feet below the Barclay limestone is a two-foot stratum of concretionary limestone covering a six-inch stratum of coal, and fifty-five feet below the Barclay limestone is a stratum of brecciated and conglomeritic limestone, locally thirty-five feet thick. The same or another stratum of breccia and conglomerate is found above the concretionary limestone mentioned above, and another thin stratum above the Emporia limestones, described below, is widely distributed in Lyon county.

(9) *Emporia Beds*, 216 feet. These comprise the Humphrey shales, including Columbia Ford limestone, 36 feet; Emporia blue limestone, 9 feet; Olpe shales, 60 feet; Emporia buff limestones, 34 feet, and Emporia reservoir shales, 77 feet. The Humphrey shales yield much salt water, to the detriment of wells. The Emporia blue limestone holds its special characteristics throughout Lyon county and probably also in the counties north and south, and is much used in the construction of foundations to houses. The Emporia buff limestones are five in number, vary considerably in physical appearance, hold many fossils in the limestone layers and in the intervening shales, and are locally used somewhat for building stones. Beneath the Emporia buff limestones the Olpe shales are in part quite arenaceous. These shales contain a thin bed of coal in the middle part. The Emporia reservoir shales are quite uniformly arenaceous and carry at the top a six-inch bed of coal.

(10) *Americus Beds*, 155 feet. These comprise the Admire shales and limestones, 120 feet; Americus limestone and shales, 35 feet. The Admire shales include some five strata of limestone and sandstone, none of which is of especial importance commercially or topographically. About ninety feet above the base the shales yield small quantities of natural gas in western Lyon county, and larger quantities at Strong City and Elmdale, in Chase county. The Americus limestone is a valuable building stone. It is dark buff in color and averages twenty inches in thickness. Six or eight feet above the Americus limestone is a six-inch layer of limestone

much used for sidewalks. The shale between these limestones is very rich in fossils.

(11) *Elmdale Beds*, 150 feet. One-third of the thickness of these beds is limestone, and the remainder is shaly limestone and shale. Of these limestones, three deserve special mention: The Friable Fusulina, twenty-four feet above the base of the beds, contains myriads of rhizopods. The Neva limestone, forty-six feet below the top, is twelve feet in thickness. The upper half was named "cotton rock" by Swallow, an early Kansas geologist, and the lower half was named "dry bone," from its peculiar appearance when weathered. The Cottonwood limestone, twelve feet from the top of the Elmdale beds, is one of the most highly valued building stones of middle Kansas. It is a white limestone, and lies in a stratum six and one-half feet in thickness. The twelve-foot shale bed above this limestone is literally full of fossils and becomes excellent soil on decomposition.

The Elmdale beds lie at the summit of the Coal Measures of Kansas. No unconformity exists between these beds and those above, but Permian fossils are increasingly abundant.

III. ROCKS OF THE PERMIAN PERIOD OF THE CARBONIC ERA.

Thickness, 2375 feet.

1.—Strata of the Lower Permian Epoch.

The rock beds found in central Kansas. Thickness, 565 feet. (The layers are described, beginning with the lowest.)

(1) *Strong City Beds*, 180 feet. These include Crusher Hill alternating shales and limestones, 140 feet. The limestones offer little resistance to atmospheric influences, and, therefore, have little influence on topography. The stratum next above is the Strong flints (Wreford limestone), 40 feet. This formation is chiefly responsible for the Flint Hills of central Kansas, because of its power to resist erosive agencies. The layers of limestone have been replaced wholly or in part by silicious material, and are much used, when crushed, for railroad ballast. The Flint Hills, or, as they were named by the earlier geologists of Kansas, the Permian mountains, extend across the state from Nebraska to Oklahoma, but are best developed in Chase, Greenwood, Butler, Elk, Cowley and Chautauqua counties.

(2) *Florence Beds*, about 159 feet. These consist of Cedar Point (Matfield) shales and shaly limestones, about 92 feet; Florence flints and shaly, buff limestone, 37 feet; Fort Riley (Florence) limestones, 30 feet. In the midst of the Florence flints are one or two heavy layers of white limestone, quarried at El Dorado for fine

building stone. The shaly, buff limestones above the Florence flints contain an abundant brachiopod fauna near Florence, and the shaly limestone above the heavily bedded Fort Riley limestone contains an abundant lamellibranch fauna near Fort Riley.

(3) *Marion Beds*, about 230 feet. The lower portion of these beds consists of various colored shales and shaly limestones, about sixty feet. The next section of the beds contains the Marion gray limestone, with more or less flint, then some yellowish shales, and Marion concretionary limestone, in all thirty feet. The Marion concretionary limestone contains many brachiopods. This is the highest and latest formation of which this is true, for the higher and later formations of the Marion beds are characterized by a very abundant lamellibranch fauna. The next 140 feet of the Marion beds consists of variously colored shaly limestones, with the Abilene conglomerate at the top. This last consists of pebbles of limestone and quartz cemented together. The great change in the physical geography of central Kansas at the close of the deposition of the Marion beds, shown by the absence of fossils from the succeeding beds and the deposition in them of large quantities of salt and gypsum, makes it seem wise to separate the Lower Permian from the Upper Permian at this horizon.

2.—*Rocks of the Upper Permian Epoch.*

The rock beds found in southwestern Kansas. Thickness, 1810 feet. (The layers are described, beginning with the lowest.)

(4) *Wellington Beds*, about 400 feet. These consist lowest of buff limestones and marls, then of colored shales and marls alternating with layers of gypsum and thick deposits of rock salt, and lastly of variously colored shales and marls. In central and northern Kansas the Wellington beds are succeeded by the massive dark brown and red sandstones of the Dakota Cretaceous; in southern Kansas the Wellington beds are covered by the sandstones, long known as the "Red Beds," belonging to the Upper Permian. Cragin has characterized the Wellington beds as made up of "a thick body of blue, gray and slate-colored shales." Thus far no fossils have been reported from them. Salt is mined at Kingman, Lyons, and Kanopolis, and is pumped at Anthony, Wellington, Hutchinson, and Sterling.

(5) *Harper Beds*, 650 feet. These are the red and variegated sandstones of the Red Beds so well exposed in Kingman and Harper counties. These beds are continuous with similar beds which outcrop in Oklahoma. The sandstones and shales were de-

posited over a continuously subsiding sea bottom, but always in shallow water, as is shown by the ripple-marks to be found in nearly every layer. No fossils have been found in these beds in Kansas, but, in Oklahoma, Gould reports the discovery of vertebrate, invertebrate and plant remains. The animals belong to Permian types, and the plants resemble Mesozoic rather than Paleozoic types, according to European standards.

(6) *Medicine Lodge Beds*, 500 feet. These consist of the Salt Plain shales, containing salt and gypsum, 150 feet; Cedar Hill sandstones, 150 feet; Flower-pot shales, 170 feet; Medicine Lodge (Cave Creek) gypsum, 29 feet. On the discovery of fossils in Oklahoma in strata geologically more than a hundred feet above the Medicine Lodge gypsum, Gould classed the strata above as Triassic; but a more careful study of these fossils shows that they belong to Permian types, and it is therefore probable that the Texas Trias does not extend north into Kansas. In southwestern Colorado the Permian Red Beds and the Triassic are unconformable.

(7) *Kiger Beds*, 260 feet. These consist of Dog Creek shales, 30 feet; Red Bluff sandstones, 200 feet; Day Creek dolomite, 10 feet; Hackberry shales, 20 feet. The fossils referred to in (6) were found in the Red Bluff sandstones. The Kiger beds close the Paleozoic in Kansas. The whole region covered by Coal Measure deposits was elevated at the close of the Paleozoic It remained dry land during the Triassic and Jurassic of the Mesozoic, and was deeply eroded; and then was submerged, in the western half of the state, beneath the waters of the ocean and covered by the deposits of the Cretaceous era, and later, as the land slowly emerged from the ocean during the rise of the Rocky Mountains in the next tier of states, west, became covered by the brackish and fresh-water deposits of the Tertiary and Quaternary eras.

IV.

BIOLOGICAL PAPERS.

"DETERMINATIONS OF SOME TEXAS COLEOPTERA, WITH RECORDS."
By ELBERT S. TUCKER, University of Kansas, Lawrence.

"ADDITIONS TO THE LIST OF KANSAS DIPTERA."
By F. F. CREVECŒUR, Onaga.

"THE EFFECT OF LIGHT ON MELILOTUS ALBA (SWEET CLOVER)."
By R. W. COPPEDGE, Mulvane.

"ADDITIONS TO THE LIST OF KANSAS COLEOPTERA, 1905."
By W. KNAUS, McPherson.

"COLLECTING INSECTS AT NIGHT."
By ELBERT S. TUCKER, University of Kansas, Lawrence.

"ADDITIONS TO THE LIST OF KANSAS ARACHNIDA."
By THEO. H. SCHEFFER, Manhattan.

"THE RED PHALAROPE (CRYMOPHILUS FULICARIUS), A NEW BIRD FOR THE KANSAS LIST."
By L. L. DYCHE, University of Kansas, Lawrence.

"NOTES ON SOME MOSQUITOES OF DOUGLAS COUNTY."
By CHAUNCEY OVERMAN, University of Kansas, Lawrence.

"SOME RESULTS OF THE UNIVERSITY OF KANSAS ENTOMOLOGICAL EXPEDITIONS TO GALVESTON AND BROWNSVILLE, TEX., IN 1904 AND 1905."
By F. H. SNOW, Lawrence.

"SOME RESULTS OF THE UNIVERSITY OF KANSAS ENTOMOLOGICAL EXPEDITIONS TO ARIZONA IN 1904 AND 1905."
By F. H. SNOW, Lawrence.

DETERMINATIONS OF SOME TEXAS COLEOPTERA, WITH RECORDS.

By ELBERT S. TUCKER, Museum Assistant in Systematic Entomology, University of Kansas, Lawrence.

ON account of personal interest in the insect fauna of Texas, due mainly to my first entomological collecting trip in the state (to Galveston, in May, 1904, as a member of a party under direction of Dr. F. H. Snow, for the University of Kansas), the writer consented to identify some beetles from the collection of the Agricultural and Mechanical College of Texas, at College Station, Brazos county, on the request of Prof. A. F. Conradi, then acting state entomologist. As a motive for the work other than the advantage accruing to the college collection, Professor Conradi proposed that a list of determinations thus obtained would be helpful in making up a general list of the Coleoptera of Texas, and the names and records herewith show the results of study of the specimens which he furnished. All determinations were personally made by comparison with named specimens in the collection of beetles of the University of Kansas, together with the aid of literature, excepting those species so indicated in the list, where special credit is given to the authority to whom the specimens were submitted in cases of uncertainty. With the exception of *Balaninus victoriensis* Chitt., all of the beetles were collected in Texas, mostly at the Agricultural and Mechanical College, to which institution they have been returned, less a few duplicates retained by kind permission. The student will notice that many dates of collecting occurred in early spring and, in fact, winter months, which indicates that where mild winters prevail a long season for insect activity is permitted.

The arrangement follows Henshaw's check-list by numbers when given.

Family CICINDELIDÆ.

19*a* Cicindela scutellaris Say, var. unicolor Dejean. Wellborn, Brazos river, March 22, 1904.

32 Cicindela vulgaris Say. Wellborn, Brazos river, March 22, 1904.

Family CARABIDÆ.

184 Calosoma lugubre Le Conte. College Station.

220 Scarites subterraneus Fabricius. College Station, March 31, 1904.

387 Bembidium variegatum Say. College Station, May 9, 1903.

617 Evarthrus heros Say. Comanche, March 17, 1904.

847a Casnonia pennsylvanica Linnæus, var. suturalis Chaudoir. College Station, January 30, 1903; Buffalo Springs, May 5, 1903.

935 Pinacodera platicollis Say. College Station, January 4, 1904. Striæ not deep; abdomen protrudes farther beyond elytra than with compared examples, regarding which Mr. Charles Liebeck has written: "About the usual form; the extent of abdominal segment beyond the elytra is variable."

1068 Discoderus impotens Le Conte. College Station, May 1, 1904. Determined by Charles Liebeck.

1120 Harpalus gravis Le Conte. Waco, September 20, 1902. Collected by L. H. Scholl.

1201 Anisodactylus piceus Le Conte. College Station, February 27 and May 1, 1904; Avalon, April 12, 1904. The brownish-tinged examples were probably freshly emerged when captured; hence, had not developed to black.

Family GYRINIDÆ.

1539 Dineutes carolinus Le Conte. College Station.

Family COCCINELLIDÆ.

3064 Cycloneda sanguinea Linnæus. College Station, May 12, 1904; also May 10, 1905 (C. E. Sanborn). Predaceous on plant-lice.

3065a Olla abdominalis Say. Sabinal, May 24, 1904.

3084 Exochomus constritatus Mulsant. College Station, May 10, 1905 (C. E. Sanborn). Predaceous on plant-lice.

3098 Brachyacantha bollii Crotch. College Station, June 4, 1903. Determined by Charles Liebeck as "large form." The yellow spaces of basal and median portions of elytra are solidly fused, without any indication of spots. Also taken at College Station, May 10, 1905, by C. E. Sanborn, who reported it as predaceous on plant-lice.

3135 Scymnus terminatus Say. College Station, August 8, 1904.

3156 Scymnus tenebrosus Mulsant. College Station, May 10, 1905 (C. E. Sanborn). Predaceous on plant-lice.

Family EROTYLIDÆ.

3202 Languria tædata Le Conte. College Station, April 12, 1903.

Family ELATERIDÆ.

4085 Lacon rectangularis Say. College Station, February 27, 1904.

Family BUPRESTIDÆ.

4575 Psiloptera drummondi Laporte and Gory. College Station, June 20, 1902. Determined by Charles Liebeck.

4639a Chrysobothris femorata Fabricius, var. alabamæ Gory. Kosse, April 19, 1904.

4750 Agrilus muticus Le Conte. College Station, April 28, 1903, and April 7, 1904.

Family MALACHIDÆ.

5007 Collops balteatus Le Conte. Wellborn, Brazos river, March 29, 1903; College Station, July 27, 1902.

Family CLERIDÆ.

5215a Chariessa pilosa Say, var. onusta Say. College Station, April 13, 1903.

Family PTINIDÆ.

5356 Amphicerus bicaudatus Say. Corsicana, March 11, 1904.

Family SCARABÆIDÆ.

5535 Aphodius serval Say. College Station, January 7, 1904. Smaller than compared examples, more deeply striate with confluent punctures, and with slightly different markings, regarding which Mr. Charles Liebeck has written: "About the usual size; markings variable."
5581 Ochodæus biarmatus Le Conte. Sabine, May 24, 1904.
5591 Bolboceras lazarus Fabricius. College Station, April 14, 1904.
5691 Macrodactylus angustatus Beauvois. College Station, March 30, 1904.
5692 Macrodactylus uniformis Horn. College Station, March 30, 1904.
5742 Lachnosterna torta Le Conte. College Station, July 8, 1904.
5894 Allorhina nitida Linnæus. College Station, July 23, 1904.
5901 Euphoria kernii Haldeman, (typical). Cedars, May 28, 1904.
5941 Trichius viridulus Fabricius. Wellborn, Brazos river, March 30, 1904.

Family CERAMBYCIDÆ.

5953 Mallodon dasystomus Say. College Station.
5955 Mallodon serrulatus Le Conte. Wellborn, Brazos river, June 24, 1904.
5962 Prionus inbricornis Linnæus. College Station, May 1, 1904.
6008 Callidium antennatum Newman. College Station, February 5, 1903.
6038 Chion cinctus Drury. Victoria, August 13, 1904.
6050 Romaleum atomarium Drury. College Station, June 10, 1904.
6115 Callichroma plicatum Le Conte. No data.
6127*a* Tragidion coquus Linnæus, var. fulvipenne Say. College Station, February 16, 1903.
6196 Neoclytus luscus Fabricius. Wellborn, Brazos river, June 24, 1904.
6201 Neoclytus erythrocephalus Fabricius. Wellborn, Brazos river, August 12, 1904.
6471 Ataxia crypta Say. Manor, October 5, 1904.

Family CHRYSOMELIDÆ.

6725 Fidia viticida Walsh. No data.
10352 Fidia cana Horn. Dripping Springs, May 17, 1904. Determined by Charles Liebeck. Badly crushed and broken.
6800 Chrysomela disrupta Rogers. Courtney, October 7, 1902. Collection of L. H. Scholl.
6821 Chrysomela auripennis Say. College Station, December 12, 1903.
6978 Haltica nana Crotch. College Station, September 19, 1903. Verified by Charles Liebeck.
7032 Mantura floridana Crotch. College Station, May 1, 1903.
7051 Chætocnema opacula Le Conte. College Station, May 1, 1903.
7055 Chætocnema confinis Crotch. College Station, May 1, 1903.

Family TENEBRIONIDÆ.

7179 Conœcus ovipennis Horn. Comanche, August 17, 1901. Determined by Charles Liebeck.
—— Emmenastus convexus Le Conte. Coleman, August 23, 1902.
7201 Epitragus acutus Le Conte. Sabinal, May 24, 1904.
7359 Eleodes seriata Le Conte. College Station.
7426 Opatrinus aciculatus Le Conte. College Station, December 20, 1903.

7438 Blapstinus pratensis Le Conte. Cororado, August 11, 1903; College Station, April 12, 1903, and February 27, 1904.
7573 Helops farctus Le Conte. College Station, June 10, 1904.

Family MORDELLIDÆ.

7780 Mordella scutellaris Fabricius. College Station, September 16, 1902.

Family ANTHICIDÆ.

7869 Eurygenius wildii Le Conte. No data.

Family MELOIDÆ.

8018 Henous confertus Say. College Station, May 28, 1903; Wellborn, Brazos river, June 24, 1904.
8083 Epicauta sericans Le Conte. Montgomery, August 24, 1903.
8123 Pomphopœa texana Le Conte. Thornberry, April 4, 1903.

Family ATTELABIDÆ.

8224 Attelabus analis Illiger. College Station, July 27, 1904.

Family OTIORHYNCHIDÆ.

8242 Ophryastes vittatus Say. Comanche, November 14, 1904.
8326 Achrastenus griseus Horn. Lovelady, March 24, 1904; Grape Vine, no data; Sidney, April 4, 1904. Determined by Charles Liebeck.
8340 Eudiagogus pulcher Fahræus. Wellborn, Brazos river, August 27, 1904; College Station, January 30, 1903.

Family CURCULIONIDÆ.

8370 Apion ovale Smith. Rockdale, June 22, 1901.
8478 Pachylobius picivorus Germar. Hughes Springs, May 11, 1904; College Station, June 10, 1904; De Kalb, August 1, 1904. The last was in prime condition, neither rubbed nor smeared.
8546 Desmoris constrictus Say. College Station; Center Point, June 1, 1904. Regarding this species Prof. A. F. Conradi has written: "This species occurs abundantly over the entire settled portions of the state of Texas definitely known."
8615 Magdalis barbiti Say. Howe, March 22, 1904.
10985 Anthonomus grandis Boheman. College Station, June 12, 1904.
8726 Conotrachelus naso Le Conte. College Station, October 20, 1904.
8741 Rhyssematus palmacollis Say. Frost, May 28, 1904. "Hillsboro, Malakoff, Victoria, and in fact it occurs all over the state," writes Professor Conradi. Variety, with costæ, apical margin and spots on elytra rusty red colored. Verified by Charles Liebeck.
8746 Chalcodermus æneus Boheman. Denison, June 27, 1904.
8760 Acalles porosus Le Conte. San Antonio, March 30, 1904; Martindale, April 14, 1902.
8902 Aulobaris ibis Le Conte. College Station, December 18, 1904.
—— Balaninus victoriensis Chittenden. Mead, Indian Territory, September 20, 1904; Lone Wolf, Oklahoma, September, 1904. Determined by F. H. Chittenden.

Family BRENTHIDÆ.

8967 Eupsalis minuta Drury. Wellborn, Brazos river, June 24, 1904.

Family CALANDRIDÆ.

8990 Sphenophorus cariosus Olivier. Moody, March 25, 1904. Determined by F. H. Chittenden.

9006 Sphenophorus compressirostris Say. No data. Determined by F. H. Chittenden.

Family ANTHRIBIDÆ.

9222 Cratoparis lugubris Olivier. College Station, January 4, 1904.

SUMMARY: Species personally determined	76
Species specially determined	9
Number of species reported	85

ADDITIONS TO THE LIST OF KANSAS DIPTERA.

By F. F. Crevecœur, Onaga, Kan.

THE following list of Diptera which have not before been listed from the state were all collected by me near my home near Onaga. A number of uniques, and a few undetermined species which are probably undescribed, are not included in this list, but will be reserved until some future time, when I expect to list them along with a lot of Microdiptera which so far I have not taken the trouble to collect. From the number of new species taken the last year or two, and the limited territory over which collecting in this order has been done, it is evident there is much yet to be done in the way of cataloguing the Diptera of the state; so that this list, as well as that of Doctor Snow, published in the Kansas University Science Bulletin, volume II, No. 5, November, 1903, may be considered only a preliminary one.

Family Tipulidæ.

Dicranoptycha sobrina O. S.
Common on weeds in the timber the latter part of May.

Erioptera graphica O. S.
Common on weeds in the timber, and also along sloughs, through the month of May. I took several specimens in the house last November and December.

Gnophomyia tristissima O. S.
Common in sweepings from weeds in heavy timber in May.

Pachyrhina punctum Loew.
A common fly on the prairie, especially on the hills and rougher ground during early summer.

Tipula angustipennis Loew.
Common; taken in the timber and in an orchard on the upland the latter part of April.

Tipula trivittata Say.
Among weeds and bushes along creeks the latter part of August.

Family Chironomidæ.

Ceratopogon variipennis Coq.
This little chironomid is occasionally taken while milking the cows towards evening, when it may be seen forcing its way among the cows' hair to satisfy its thirst for blood. The one specimen in my collection was taken May 29, 1905.

Family Mycetophilidæ.

Mycetophila punctata Meig.
The only specimen I have of this species was found under a board lying on the ground in the dooryard March 27, 1903.

Family SIMULIIDÆ.

Simulium venustum Say.

One specimen, taken May 22, 1901.

Simulium vittatum Zett.

This little pest is often abundant the latter part of March and early in April, hovering about and entering horses' and cattle's ears, where it gorges itself on the animals' blood. Last year I found the species quite common as late as November 23.

Family STRATIOMYIDÆ.

Odontomyia (snowi) hieroglyphica Olivier.

Common from early summer until fall, frequenting the flowers of Compositæ.

Pachygaster maculicornis Hine.

I have no specimens of this species in my collection, but in Aldrich's catalogue of North American Diptera this species is credited to Onaga, Kan.; so I suppose a specimen was included among a lot of flies sent by me to Professor Hine.

Family TABANIDÆ.

Tabanus bicolor Wied.

A few specimens of this fly were taken on swampy ground during June. The male was taken frequenting the flowers of Cicuta maculata July 16, 1903.

Tabanus costalis Wied.

This tabanid is common during the hot summer months, attacking cattle and horses.

Tabanus dodgei Whitney.

This fairly common species I have taken only while plowing or listing, when it would be seen flying about the working horses. Occurs only in May.

Tabanus lineola Fabr.

A number of Tabanûs which I thought were longus, sent to Professor Hine, of the State University of Ohio, last fall, were mentioned by him in a communication to me as T. lineola.

Tabanus (Tectus) sulcifrons Macq.

This large fly abounds near wooded streams during June and July, where it makes life unendurable to live stock confined in lots near the creeks.

Family LEPTIDÆ.

Cœnomyia furruginea Scopoli.

Some years this fly is quite abundant among the rank growth of weeds in the timber along the creeks during the first part of June.

Xylomyia (Subula) parens Wills.

A specimen was taken in the timber on French creek June 7, another in our orchard on the prairie June 13, and a third specimen was taken in our house May 28.

Chrysopila testaceipes Bigot.

Quite common on the rank herbage in the heavy timber along the larger streams during the month of June.

Family BOMBYLIIDÆ.

Spogostylum œdipus Fabr.

Common about flowers on the prairie during July and August.

Anthrax ceyx Loew.

The only time I have met with this species was on August 16, 1897, when I took a half a dozen or so on the blossoms of a species of Solidago at the edge of the timber along French creek, four miles north of Onaga.

Anthrax sinuosa Wied.

I have taken this on the prairie and in the timber; it occurs from June until August.

Bombylius major Linné.

I have taken this species on blossoms of the apricot from April 13 to April 17.

Family ASILIDÆ.

Leptogaster varipes Loew.

Some years quite common; on the prairies during the latter part of June.

Ospriocerus eutrophus Loew.

This rare and pretty species I have taken in rank grass on the prairie in July.

Ecthodopa pubera Loew.

Occurs from the last of May to the last of August along the larger streams among the weeds in the timber.

Holcocephala abdominalis Say.

Abundant along sloughs, where it frequents flowers growing in such situations. June to July.

Atomosia puella Wied.

Common. I have taken it along sloughs and in the timber along the creeks from June to September.

Ommatius marginellus Fabr.

The two specimens I have of this rare species were taken the first week in July, one in the timber and the other on the prairie.

Erax rapax O. S.

A rather uncommon species; taken on the prairie in September. I have a pair taken *in copula*, and find the sexes differ considerably.

Tolmerus annulipes Macq.

What has been determined as this species was taken in heavy timber early in July.

Family DOLICHOPODIDÆ.

Psilopodinus sipho Say.

Abundant in the timber, where it may be seen disporting itself in the sunlight upon the tops of the weeds. Occurs from the last of May till the last of June.

Diaphorus leucostomus Loew.

One of my notes says: Apparently lapping dew on the leaves of box-elder, May 23. Also taken in sweepings on the grass and weeds in the pasture on the prairie June 24.

Dolichopus scoparius Loew.

I have but one specimen of this species in my collection, which was taken in heavy timber May 17, 1898.

Hybos triplex Walk.
Taken in sweepings on the prairie May 26, 1897.

Hilara femorata Loew.
The one specimen I have of this species was taken May 12, 1901. My notes do not say in what situation, but I think I recollect taking it on the window of our residence.

Rhamphomyia fumosa Loew.
Common on the weeds in the timber during May and June.

Family SYRPHIDÆ.

Microdon fuscipennis Macq.
A single specimen taken about fifteen years ago is all that I have ever seen of this species. The specimen has no date or other labels, as I put no labels on my specimens then.

Mixogaster breviventris Kahl.
A number of uniques given to Professor Kahl while he was yet at the Kansas State University contained a specimen which he determined as this species, but as he retained the specimen, with its accompanying note, I cannot tell when or in what situation it was taken.

Chrysotoxum derivatum Walk.
An uncommon species. Have taken it frequenting flowers along a slough the last week in June; also in heavy timber the last week in August.

Baccha fascipennis Wied.
A few taken in heavy timber the middle of June.

Mallota posticata Fabr.
I have met with this species but once; a half-dozen or so were sunning themselves on the tops of Impatiens pallida on French creek June 12, 1904.

Xylota chalybea Wied.
One of my uniques determined by Professor Kahl. I have a fly taken since, which from memory I think is this species, which was taken May 12, 1901.

Family TACHINIDÆ.

Leskia analis Say.
Taken on weeds in the timber the latter part of July.

Leucostoma senilis Town.
On weeds and bushes in the timber the last week in June, and on the blossoms of Solidago in the pasture the middle of September.

Œstrophasia ochracea Bigot.
Taken on the prairie in September and October. I once found a specimen in water put in a sorghum evaporator over night.

Œstrophasia signifera Van der Wilp.
Taken the last of May.

Ocyptera carolina Desv.
Taken in beating net on the prairie the latter part of June, and on blossoms of Solidago, also on the prairie, early in September.

Acemyia tibialis Coq.
Taken on the prairie June 22, and at light September 22.

Archytas aterrima Desv.

A common species. The only specimens in my collection are among some of my earliest captures in entomology and bear no date or other labels.

Sarcophaga sarraceniæ Riley.

Like the preceding species, my specimens of this bear no date or other labels. A common species.

Cynomia cadaverina Desv.

My remarks on the two preceding species also apply to this.

Myiospila meditabunda Fabr.

Rare. Taken under a piece of cloth placed in the crotch of a tree in the dooryard, to serve as a trap for insects, April 20, 1897.

Ophyra leucostoma Wied.

Taken on Salix longifolia April 25; also taken while maintaining itself in a stationary position on the wing, in the orchard, August 18.

Phorbia acra Walk.

Taken in the orchard April 23; also at the edge of heavy timber along the creek June 16.

Phorbia cinerella Fall.

This little pest, to which I have applied the rather opprobrious epithet of "snot fly," on account of its persistency in trying to fly to one's nose when one is affected with catarrh, is quite common all summer from April on. I once reared a specimen from a pupa found in the shriveled skin of a Geophilus perforans under a stone on the prairie.

Caricea antica Walk.

Found among sweepings made in the orchard April 24; also collected in sweepings made on the prairie May 12.

Family SCATOPHAGIDÆ.

Cordylura gracilipes Loew.

Taken in sweepings in heavy timber in May.

Scatophaga furcata Say.

Common in the timber in July.

Family SCIOMYZIDÆ.

Sciomyza nana Fall.

Beaten from Ambrosia artemisiæfolia October 23, 1897.

Tetanocera arcuata Loew.

A common species; taken in the orchard in April, and in heavy timber in June.

Tetanocera plumosa Loew.

Taken on vegetation growing on swampy ground the middle of June.

Tetanocera saratogensis Fitch.

Common in pastures in May.

Tetanocera umbrarum Linné.

Taken on weeds in a pasture in October.

Family SAPROMYZIDÆ.

Lonchæa rufitarsus Macq.

This species frequents carrion, and my specimens were taken the middle of April.

Palloptera superba Loew.

A rare species. One of the two specimens I have was taken in the timber on a small creek July 7, and the other in the heavy timber on a larger stream July 5.

Sapromyza crevecœuri Coq.

Taken on hazel bushes from the last of June till early in August.

Sapromyza lupulina Fabr.

Taken on weeds in the timber from the last of May till the middle of June.

Sapromyza philadelphica Macq.

Taken on prairie, and on weeds at the edge of timber, during the latter half of June.

Sapromyza vulgaris Fitch.

Swept on the prairie May 30.

Family ORTALIDÆ.

Pyrgota valida Harris.

I have taken this species a number of times in my cloth traps in the trees in the dooryard the latter part of April.

Amphicnephes fasciola Coq.

The types of this species were collected by myself. It is a common species, and is found by beating the vegetation growing in pastures from June until September.

Tritoxa incurva Loew.

One of the uniques determined by Professor Kahl, and my remarks on Mixogaster breviventris (*supra*) also apply to this species.

Pterocalla strigula Loew.

A rare species, and the only specimen I have was taken by sweeping in heavy timber May 18, 1898.

Euxesta notata Wied.

Taken on carrion April 24, and in sweepings in heavy timber May 18.

Family TRYPETIDÆ.

Straussia longipennis Wied.

This species has been listed by Doctor Snow. I have specimens which Professor Hine determines as this species but which I think is a different species, as it is quite different from the form usually known by this name. The wings of my species are narrower than common S. longipennis, and the markings in the wings form a dark band occupying about two-thirds of the costal border of the wing. I feel satisfied that when the species comes to be more thoroughly studied it will be found to be distinct from longipennis.

Eutreta rotundipennis Loew.

On weeds in heavy timber the middle of June.

Eurosta comma Wied.

Taken in fair numbers in a pasture early in October.

Eurosta reticulata Snow.

A rather scarce species. Taken on the prairie May 25, 1900.

Family MICROPEZIDÆ.

Calobata lasciva Fabr.

This common species may be taken in the timber early in June while it disports in the sunlight on the tops of the weeds.

Family SEPSIDÆ.

Prochyliza xanthostoma Walk.

I have taken this species in my sweepings in the orchard from the latter part of April to early in May.

Family PSILIDÆ.

Psila lateralis Loew.

Occurs on vegetation along sloughs and in the timber during the first half of June.

Family EPHYDRIDÆ.

Ochthera mantis DeG.

Common on the wet ground at the edge of a stock pond on my place in June. One specimen I have was swept from the vegetation growing along a slough June 4.

Family OSCINIDÆ.

Chlorops proxima Say.

Swept in a low meadow the latter part of May; also taken on blossoms of Solidago in the pasture September 11.

Hippelates plebejus Loew.

I have taken this species the latter part of June while milking, while it was crawling over the cows, being presumably attracted by the smell of fresh milk.

Family DROSOPHILIDÆ.

Phortica vittata Coq.

One specimen I have was taken May 12, 1901.

Family AGROMYZIDÆ.

Agromyza neptis Loew.

Taken while evidently feeding on the dew on box-elder leaves in the orchard in May, and swept on the prairie June 22.

THE EFFECT OF LIGHT ON MELILOTUS ALBA.

(Sweet Clover.)

By R. W. Coppedge, Mulvane.

THE *Melilotus alba*, or Sweet clover, was taken up as an interesting plant to study because it seemed able, to a remarkable degree, to adapt itself to its surroundings. It is one of the earliest plants to appear in the spring, coming up, especially on a south or southeast slope, two or three weeks before any other plant. By the last of March the leaves begin to appear, and on every bright, sunny day the work of forming starch is going on in its laboratories.

By means of its tubercles it is able to extract nitrogen from the atmosphere. We find it, therefore, in great abundance in blue shale and clay soil, where few, if any, other plants can grow.

The readiness with which the leaves and growing stem respond to the light enables the plant to protect itself from heat and cold, and keep its leaves in the best position for forming starch.

Experiments have been made by the author during the months of April and May of 1899 and 1900 to find out, if possible, just how rapid these processes were.

First, as to the nutation of leaves and stems: Kellerman, in his paper read before the Kansas Academy of Science, proved that the *Helianthus annuus* did not nutate, thus disproving popular tradition. He had only worked on plants, however, after anthesis.

Schaffner proved, by a number of experiments conducted in 1896–'97, that prior to anthesis the leaves and flower-heads nutate during the day in such a way as to stand at right angles to the sun's rays. At night the leaves drop, with points turned toward the ground, occupying a sleep position.*

W. P. Wilson and Jesse M. Greenman conducted a number of experiments along the same line on the *Melilotus alba*. Their experiments were to show the regular daily movements of the plant. They found four positions which the leaves take, three normal and one abnormal. The first or normal day position may be seen in the morning or evening. The leaves are spread out, with the blades at right angles to the sun's rays.

In the second or hot-sun position the leaves stand with their tips pointed toward the sun, the blade parallel to the sun's rays.

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* Observations on the Nutation of *Helianthus annuus*, Bot. Gaz., vol. 25, pp. 395–404.

In the third or sleep position the leaves sink down, the tips are pointed toward the ground. The two lateral leaflets lie closely against the sides of the terminal leaflet, thus exposing the least possible surface to cold and transpiration.

The fourth position was brought about by covering the plant with red glass. The sleep position was thus modified some, for in this case the leaves, instead of pointing straight down to the ground, were at an angle and pointed toward the base of stem.

The author's results have agreed with Wilson's with one or two slight exceptions. I did not perform the experiment with the red glass, but I have noticed the leaves assume that position when the plants were in pots when first taken up, before the root-hairs had grown out again.

Wilson claimed that it was moisture or transpiration that caused the leaves to assume the hot-sun position. His experiment was as follows: Two potted plants were chosen; one was covered with a bell jar; the other was left standing in the open air. The light was the same in each case. The leaves on the plant in the open assumed the hot-sun position; the leaves on the one under the bell jar did not.

I performed the same experiment several times with potted plants and with plants in the field, without being able to find any difference in the position of the leaves when they were in the saturated atmosphere under the bell jar or in the open air.

A bell jar was placed over a plant in the field at 8:30 A. M. By twelve o'clock the atmosphere under the jar was saturated, as shown by the moisture which ran down the sides of the jar. On comparing the number of leaves which had assumed the hot-sun position with those of a plant standing near by under apparently the same conditions, there was no difference in the number which had turned their tips to the sun.

The same experiment was performed by covering one branch of a plant and leaving the other open to the air, but no difference could be noticed in the number of leaves which assumed the hot-sun position on the two branches.

The angles of a number of leaves were taken after they had taken the hot-sun position, and then a bell jar was placed over the plant. In a few minutes the atmosphere under the jar was saturated, but no drop from the hot-sun position occurred during one hour and thirty minutes, as shown by the angles.

A plant was covered with a bell jar at 8:30 A. M. The air was soon saturated. At eleven o'clock the leaves took up the hot-sun

position. At one o'clock the jar was removed. In a few minutes the blades hung limp on their pulvini, showing that the stomata were all open. The change was so sudden that they were not able to close, as they would under normal conditions. Transpiration went on, therefore, and the leaf had soon given up too much water to stand erect.

Three plants in the open on which measurements had been taken turned their leaves each day, at about eleven o'clock, into the hot-sun position, with angles ranging from eighty-five to ninety degrees, the ground being dry. A heavy rain came on and soaked the soil, and for the next two days the leaves did not take up the hot-sun position, although the temperature was the same, twenty to twenty-three degrees centigrade, and the light strength the same.

A potted plant in the window turned its leaves each day to the light in the hot-sun position. Then the plant was supplied with plenty of water. During the next two days the leaves did not assume the hot-sun position. The temperature in each case was about the same, and the light readings for the second day showed more light than before.

From these experiments the conclusion is that the hot-sun position depends on the amount of moisture in the soil and not on the condition of the atmosphere, and that the opening and closing of the stomata depend on the relative humidity of the atmosphere.

As will be more clearly shown later in the accounts of the experiments, nutation took place in almost the entire stem in the young plant, being most noticeable in the pulvinus and decreasing towards the roots. As the plant grows older the region of nutation grows less and less. The pulvinus is so arranged as to permit the leaf to twist in any direction, so that the blade may stand at almost any angle to its petiole.

The movement originated in the leaf blade and extended from there down the stem. That the leaf was the source of the movement was proven by shading the part below the lamina, when the nutation proceeds the same as before. When the lamina above was shaded between dark papers there was no nutation. This agrees with Schaffner's experiments on *Helianthus*.

A number of experiments were made to find whether the movements of the plants and leaves depend on the light only, or whether they simply had a regular daily movement. A few experiments were sufficient to show that the plants would move in any direction to face the light, and that light alone was the cause of the normal day movements.

Schaffner says that the *Helianthus annuus* begins to nutate toward the east before the morning light could affect it. The *Melilotus alba*, however, moves only when acted upon by light. It will remain constant for days facing one direction if the light comes from that direction. It will change the position of its leaves very quickly if the direction of the incident ray is changed.

After these points were determined, an attempt was made to discover, if possible, the relation existing between the rate of movement and the strength of the light. Several methods were used in these experiments. Some healthy potted plants were placed in the laboratory window. The leaves soon all turned their faces to the light. The pot was then turned half-way round. The leaves then twisted on their pulvini, rose or fell, the stem changed its curve, so that in about thirty minutes to one hour the leaves were all again facing the light.

The easiest movement, judging from the time required, was a twist at the pulvinus. The second was where the leaf merely fell or dropped down. The one requiring the most time was where the leaf had to rise against gravity. This latter movement was accelerated when the leaf was lifted either by the wind or one's finger. This accounts for the sudden jumps which will be seen in the record of the movement of leaves taken when the wind was blowing.

Second method: A box sufficiently large not to touch the plant was taken, one end removed, and the inside lined with dark paper. This was then placed over a plant in the field, with the end left open. The light thus came to the plant from one direction only.

In some experiments the box was left over the plant during the night, facing the west, so that the leaves in the morning faced west. The box was then removed and the morning sun shone on the plant. The leaves quickly faced about to the east. Other experiments were made by placing the box over the plant at eight o'clock A. M., so that the light came from the west. The leaves at this time were all turned to the east, but they turned in a short time to the west.

The same results were secured by letting sunlight fall on the plant from the east at five o'clock in the evening, or by letting the light come from the north at noon. It was found, however, that, if the box was left over a plant for two days, those leaves which were in the dark part of the box, and were therefore not very strongly illuminated, were not able to recover from the sleep position the morning of the third day, even when exposed to the morning sunlight for two hours.

Following is a statement of some of the experiments. The angle of the leaf was measured by means of a goniometer used for determining the height of trees. The light strength was determined by means of a light machine invented by Professor Stevens, of the State University, who took a large number of the readings recorded.

Experiments made on a plant in a window:

EXPERIMENT No. 1.

Temperature, 20° C. Time, 1:30 to 2:00 P. M.
Light readings: Red, 0.372; blue, 0.328; green, 0.89.

	Leaf No. 1.	*Leaf No. 2.*
Dropped	37°	46° and 60°
Rose	5°	17°

EXPERIMENT No. 2.

Temperature, 21° C. Time, 1:00 to 3:00 P. M.
Light readings: Red, 0.605; green, 2.94; blue, 6.432.

	Leaf No. 1.	*Leaf No. 2.*	*Leaf No. 3.*
Time, 30 minutes	19° drop.	18° drop.	15° drop.
25 "	19° "	38° "	20° "
35 "	8° "	11° "	
30 "	27° "		
20 "	14° twist.	16° twist.	
20 "	20° "	30° "	
20 "	35° "	55° "	

EXPERIMENT No. 3.

Temperature, 22° C. Time, April 3, 8:25 A. M.
Light readings: Red, 0.3477; green, 1.404; blue, 3.65.

	Leaf No. 1.	*Leaf No. 2.*
Time, 60 minutes	13°	30°
Petiole of leaf twisted.		
Time, 30 minntes	18°	20°

EXPERIMENT No. 4.

Temperature, 17° C. Time, April 4, 8:55 A. M.
Light readings: Red, 0.295; green, 1; blue, 7.628.

	Leaf No. 1.	*Leaf No. 2.*	*Leaf No. 3.*
Time, 35 minutes	20° drop.	20°	6°
30 "	13° "	12°	9°

Experiments made on a plant in the field (the leaves were turned to the west, because a box had been placed over the plant):

EXPERIMENT No. 1.

Temperature, 18° C. Time, April 26, 8:35 A. M.
Light readings: Red, 8.33; green, 22.75; blue, 43.73; yellow, 13.16.
Leaf rose 8°, fell 18°; stem moved 15° in 15 minutes.

EXPERIMENT No. 2.

Temperature, 23° C. Time, May 7, 9:00 A. M.
Light readings: Red, 1.404; blue, 28.63; green, 4.31.

	Leaf No. 1.	*Leaf No. 2.*	*Leaf No. 3.*	*Leaf No. 4.*
Time, 35 minutes	15° drop.	15° drop.	20° drop.	25° twist.
25 "	14° "	13° "	15° "	20° "

EXPERIMENT No. 3.

Temperature, 23° C. Time, May 8, 8:55 A. M.
Light readings: Red, 5.614; green, 50; blue, 10.93.

	Leaf No. 1.	*Leaf No. 2.*	*Stem rose.*	*Stem twist.*
Time, 40 minutes	12°	9°	10°	40°
20 "	5°	8°	7°	20°
5 "	4°	4°		
5 "	7°	3°		
10 "	9°			

EXPERIMENT No. 4.

Temperature, 23° C. Time, April 23, 8:35 A. M.
Light readings: Red, 4.31; green, 65.56; blue, 43.73.

	Leaf rose.	*No. 1. Leaf fell.*	*Leaf fell.*
Time, 20 minutes	7°	30°	27°
20 "	15°	33°	30°
20 "	10°	20°	
40 "	39°	40°	
5 "	7°		
11 "	11°		
12 "	12°		
13 "	15°		

Twist of petiole, 40° in 40 minutes, and 50° in 50 minutes.
Twist of stem, 8° in 30 minutes, and 9° in 40 minutes.

Some experiments were made to determine the mutual relation of light and carbon dioxide gas in forming starch. They were as follows: Stomata were found on both sides of the leaf in the ratio of fifteen on upper to twelve on lower, under one-quarter objective and one-inch eyepiece.

Leaves of a plant which had been covered over night, and from which all the starch had gone, were treated—one with cocoa-butter on the upper side, one with cocoa-butter on the lower side, one with cocoa-butter on both sides. After several hours, the leaves were examined for starch by cross-sectioning the lamina and treating with chloral hydrate iodine and examined under the microscope. The leaf which had cocoa-butter on the under side was found to have starch grains scattered through all the cells. The one treated with cocoa-butter on the upper side had starch scattered pretty well through all the cells, excepting the long palisade cells on the

upper side. Here the grains were few. The third, which had been treated on both sides, had no starch.

The cocoa-butter was applied by warming it slightly and spreading it in a thin film over the leaf, so as to exclude all carbon dioxide gas. This experiment was performed several times, with the same results.

To be sure the light was not excluded by the cocoa-butter, an experiment was made in the same way by sealing a leaf which contained no starch between two one-inch cover-glasses. The sealing was done by fastening the edges of the cover-glasses together with cocoa-butter or salve, the butter coming in contact with the leaf at the petiole only. Thus all carbon dioxide gas was excluded, but the light had free access. After a few hours, starch was found in the other leaves of the plant but none in those so treated.

On April 12 other leaves without any starch, while yet on the plant, were placed between two squares of dark paper held in place by clasps. Thus light was excluded but air was not. The squares of paper were not as large as the leaf; so part of it was exposed to the light. When examined, starch was found only in the part exposed to the light. The part of the leaf under the black paper had no starch.

On April 29, at six o'clock P. M., some leaves which were full of starch were treated as above with cocoa-butter—some dorsal only, some ventral only, some on both sides; hence, in the latter case, all light was excluded. The next morning all the starch had gone out of all the leaves excepting those treated on both sides. These were full of starch.

On May 2 branches with the leaves full of starch were broken off and placed, at six o'clock P. M., in dark drawers. After sixteen hours the starch had gone from all the cells of the leaves excepting a few of the palisades. Parts of leaves treated in the same way did not lose their starch.

Hence, when air only was present, the starch went out of the leaf, but only when light and air both were present was starch formed

A number of experimnts were performed to determine how long it required, when conditions were favorable, for the plant to form starch.

With the temperature at 20 deg. C., and light readings, red 19, yellow 20, green 20, blue 53.06, starch formed in one hour and thirty minutes. With the temperature 19 deg. C., light readings,

red 1.9, yellow 2.66, green 4, blue 10.40, a cloudy day, starch formed in two hours and fifty minutes.

Later a few spring rains fell, and the new leaves which opened out were of a much lighter green than the old ones. When the temperature was 20 deg. C., and the light readings were, red 19, yellow 20, green 20, blue 56.06, it was found that it took one hour and thirty minutes to form starch in the old leaves, and two hours and thirty minutes in the young leaves.

Comparisons of the amount of light used in the two cases were as follows: Amount of light coming to the plant was, red, 19; yellow, 20; green, 20; blue, 53.06.

Amount of light which passed through dark leaf was, red, 0.1384; yellow, 0. 2647; green, 0.6; blue, none. Amount of light which passed through colorless leaf was, red, 7.826; yellow, 0.9; green, 18.5; blue, 3.

The amount of light reflected from the two leaves was the same in each case, and was as follows: Red, 0.5538; yellow, 1.125; green, 1.5; blue, 1.154.

Hence, from these figures, we get the amount of light used by each leaf in making starch as follows:

	Dark green leaf.	*Yellow new leaf.*
Red	18.3076	10.602
Yellow	18.6103	17.955
Green	17.9	.....
Blue	51.906	48.906

Some experiments were performed to determine at what time in the night the starch left the plant. On the morning of April 14, it having turned cool in the night, the temperature dropped to 10 deg. C. At seven o'clock the leaves showed starch around the sieve-tubes; none in the palisade cells.

April 28 leaves taken every hour during the night were examined. Starch grew gradually less after midnight. It was nearly all gone at four o'clock; all gone at 5:15. Temperature, 20° C.

April 29 leaves picked every hour were examined. There was a gradual decrease of starch after midnight, and at five o'clock no starch was left. Temperature, average, 20° C.

On the morning of the 12th of June similar experiments were made. Although the temperature was much higher at this time, the starch remained later in the leaves, because of the greater abundance the evening before. The leaves examined in April showed scattered grains of starch, while those examined in June showed starch in thick masses crowding all the cells.

The leaves were examined every half-hour, beginning at four o'clock. At this time the cells were crowded with starch, especially around the sieve-tubes. The outer palisade cells, next to the epidermis, showed a decrease of starch. At 4 : 30 most of the starch had gone out of the palisade cells and there was a considerable reduction in all other cells. At five o'clock starch was left only in the sieve-tubes and a little in the cells bordering them. At 5 : 30 all the starch had gone from the leaf. At six o'clock starch began to appear again in the palisade cells.

Thus it will be seen that starch disappeared first from the palisade cells and reappeared there first.

ADDITIONS TO LIST OF KANSAS COLEOPTERA, 1905.

By WARREN KNAUS, McPherson.

DURING the year 1905 fifty-eight species of Coleoptera have been recorded as new to the Kansas list. Those marked "Leconte" and "Horn," without locality, are recorded in descriptions by those writers, but have not been found by local collectors.

148 Calosoma luxatum Say. (Leconte.)
148*a* Calosoma var. striatulum Lec. (Leconte.)
1562 Hydrochus squamifer Lec. Several specimens, Galena, Kan., collected by Ebb Crum.
Agathengis sp. McPherson; two specimens; May.
Cartodera argus Fall. McPherson; one specimen.
3696 Epurea helvola Er. Douglas county. Snow.
Hydnocera knausii Wickh. Three specimens: Belvidere, July; McPherson, October 10; Topeka, June. Smyth.
4252 Drasterius livens Lec. Wilson county and Onaga.
5251 Ernobius granulatus Lec. Bowditch collection.
5266 Oligomerus alternatus Lec. Onaga. Crevecœur.
Petalium seriatum Lec. Salina.
Catorama confusus Fall. Salina and Onaga.
Catorama mutans Fall. Benedict, Wilson county, May.
Catorama vexatum Fall. Recorded from Kansas in Fall's revision of Ptinidæ.
Catorama nigritulum Fall. Onaga, June. Crevecœur.
Catorama angustum Fall. Hamilton county. Snow. Wallace county, July.
Ptilinus lobatus Cas. Salina, and Republican valley south of Superior, Neb., June. Erroneously listed as thoracicus Rand.
Bostrychus cornutus Horn. Topeka, June. E. G. Smyth.
5434 Canthon vigilans Lec. One specimen; McPherson.
Psammodius sp. Topeka; one specimen. E. G. Smyth.
Aphodius knausii Fall. Englewood, June 26; numerous specimens.
Aphodius, sp. near seabriceps Lec. One specimen; Topeka. Smyth.
5550 Aphodius consentaneous Lec. (Horn.)
Cotalpa subcribrata Wickh. Medora and westward.
6100*a* Molorchus corni Hald. One specimen; Topeka. Smyth.
6282 Strangalia acuminata Oliv. Onaga. Crevecœur.
6389 Monohammus marmorator Kirby. One specimen; Topeka. Smyth.
6400 Goes pulverulenta Hald. On catalpa; Topeka. Smyth.
6436 Lepturges signatus Lec. Topeka. Smyth.
6439 Lepturges regularis Lec. Topeka. Smyth.
6497 Oberea quadricallosa Lec. On hackberry, Topeka. Smyth.
6554 Zeugophora varians Cr. (Horn.)
6595 Megalostomis subfasciata Lec. (Horn.)
6761 Metachroma marginalis Cr. (Horn.)

6766 Metachroma lateralis Cr. (Horn.)
10361 Graphops beryllinis Horn. (Horn.)
Phyllobrotica nigritarsus Linell. One specimen; Salina.
6853 Phyllechthrus gentilis Lec. (Horn.)
6868 Luperodes merica Say. (Horn.)
6907 Galerucella decora Say. Onaga, June 26. on Polygonium. Crevecœur.
6922 Hypolampsis mellyi Cr. (Horn.)
6929 Œdionychis lustrans Lec. Medora; one specimen, June.
6946 Œdionychis scalaris Melsh. (Horn.)
Epitrax, sp. near cucumeris Harr. Two specimens; McPherson.
10427 Diphaulaca bicolorata Horn. (Horn.)
7011 Longitarsus subrufus Lec. (Horn.)
10449 Glyptina bicolor Horn. (Horn.)
7044 Chætocnema elongatula Cr. (Horn.)
7047 Chætocnema decipiens Lec. (Horn.)
7059 Psylloides convexior Lec. Douglas county. Snow.
10457 Psylloides elegans Horn. (Horn.)
Tomoxia sp. One specimen; Onaga. Crevecœur.
Dilandius myrmecops Cas. One specimen; McPherson, April.
Trachyphlœus, sp. not described. McPherson, Onaga, and Lawrence.
8241 Calyptillus cryptops Horn. Four specimens; Meade, May.
8461 Macrops delumbis Gyll. McPherson; one specimen.
8565 Brachybamus electus Germ. One specimen; Medora, May.
8843 Ceutorhynchus convexicollis Lec. Two specimens; Meade, May.

COLLECTING INSECTS AT NIGHT.

By ELBERT S. TUCKER, Museum Assistant in Systematic Entomology, University of Kansas, Lawrence.

COLLECTING insects at night is by no means engaged in to the same extent as day collecting, yet night collecting is far from being neglected. Insects in their season abound by night as well as by day, but those which are active at night seldom appear by day, and those that are found in daytime are not generally caught at night, although a lapping of the two tendencies is evidenced by some common forms which appear only at twilight or dawn. Consequently, two popular distinctions among insects are established by reason of their choice of either daytime or night-time for period of activity, and the terms *diurnal* and *nocturnal* are familiarly applied. Aside from the preference for day work rather than night work in any pursuit, and collecting is no exception in this respect, the inducements for collecting at night are, however, considering the abundance, importance and variety of nocturnal forms, about equal to those attending day collecting. Some collectors assert that discoveries of new species are more certain to reward night work than operations by day; hence the thorough collector needs to divide his time somewhat between day and night.

In contemplating the present scope of entomology, the student becomes impressed by the remarkable number of species now described in our bulky literature, and is apt to believe that about every kind of insect which thrives in our country, or wherever exploration has been conducted, is scientifically known and named, and in many cases renamed, in consequence of which little chance remains for finding new material. This notion cannot endure long in the face of investigation of what forms of insects can be found especially at night. The author can state that as far as his own captures are reported, in regard to some hymenopterous parasites,* more than two species were captured to one old species, and most of them were collected at night in Lawrence. Whether this is an exceptional case or not, the study of other groups collected at same time under the same conditions is needed for the purpose of determining what percentage of new species to old species would constitute an average estimate, particularly in regard to Microdip-

*See article entitled "Notes and Descriptions of Hymenoptera from the Western United States in the Collection of the University of Kansas," by H. L. Viereck, in Transactions Kansas Academy of Science, volume XIX, pp. 264-326.

tera and Microlepidoptera, the chief associates taken with the parasites. Much depends on the extent to which any group has been studied that leaves a chance more or less open for addition of new species; for instance, the beetles are so thoroughly known that any chance of finding new species is comparatively slight, while the Microlepidoptera, Microdiptera and hymenopterous parasites are in lessening proportion imperfectly known, and new species are quite frequently detected.

The enthusiast, indeed, who expects the accomplishment of great possibilities in entomological research within the next few years may claim, further, that the prospect for rich systematic discovery lies in going over the field the second time, to which we are already becoming accustomed, for the purpose of revision, and, in connection, the search for night forms deserves extended recognition, while at any time it presents a hopeful incentive to collect in territory otherwise considered well worked. Really, in spite of the present advanced state of entomological science, the combined knowledge of the insect fauna of our country in general is, perhaps, still regarded by some workers as having progressed but little beyond the superficial stage. In fact, the names of new species are constantly swelling our already crowded lists, and, what is remarkable, discoveries of new species are often made in old-settled localities long familiar to entomologists. Attention has been given principally to the larger forms of insects, while a host of little things, the greater proportion probably being night denizens, doubtless remain unknown everywhere, and all that is needed to disclose them to science is a larger number of diligent workers, both collectors and students.

Not only the beginner in insect study, but the teacher and experienced collector as well, can find instructive diversion combined with healthful recreation in the cool, refreshing, open air of summer nights by devoting part, if not all, of evenings to collecting specimens. Possibly the student may be regularly employed by day in business or trade, especially since many students are obliged to work in summer-time; but in the evenings, when the time is usually one's own, a grand opportunity for acquaintance with our insect neighbors awaits him ready at hand, whether the interested person is situated in country or city. Employment by day, then, no matter how confining it may be, in business or other calling, should not bar a person from making a collection of insects as long as evenings are free, and in this respect entomology has an advantage over other

branches of science in which material cannot be so readily secured at night.

Changes of weather and influence of the moon have a wonderful effect on the movements of insects at night. Warm, damp, dark nights, without perceptible wind, afford the best conditions towards inducing night insects into activity; then they may be noticed in throngs hovering about every exposed light. At other times, when insects do not appear in ordinary numbers at the lights, the principal reasons may be due to a chilliness of the air or to a strong wind, in which cases only few of the stronger and hardier species seem to venture out of their haunts. Even on other occasions, when there is no shining moon, and all conditions are apparently favorable for impelling insects to fly, the collector will sometimes meet with disappointment, and be unable to account for the scarcity of specimens around artificial lights. At such times, as well as when the moon is shining, the collector should direct his attention to other methods of collecting, such as the sweeping of herbage, which can be resorted to particularly on chilly or windy nights; and, in case of moonlight, he should remember to select the shaded portions in thickets, woods, orchards, or parks. A friend with whom I have used the sugar bait relates that he never noticed any difference in collecting whether the moon shone or not; in fact, he paid no regard whatever to either moonlight or dark nights, but went ahead just the same for one night as another. Doubtless the insects prefer to remain in hiding whenever the moon shines, for they are commonly active before the moon rises, if after dark, or should it set before dawn, they stir about somewhat. The suddenness with which good collecting has failed time and again just at the rising of the moon is remarkable.

The practical collector will soon learn to note the conditions prevailing each night before he starts operations, and so can guide himself in the selection of the proper course to adopt in obtaining the best results. On rainy nights he might open a window or two of his room opposite to the direction of the wind, thereby being shielded from rain and in the path of insects flying against the stream, and there catch whatever comes in to the light; for, in warm weather, such conditions are often extremely favorable towards bringing out the insects. Really there is no time throughout the growing season, whatever the conditions may ordinarily be, but what can be used in one way or another to good advantage in collecting. The difficulty will be to keep up the mounting of the specimens as fast as the collecting is done. Only the novice will re-

quire instruction in regard to the mounting and preservation of specimens; otherwise the subject need not be mentioned here. Directions for mounting, also for preparing a collecting outfit, are usually contained in elementary guides to the study of insects, and a book of this kind should be in the hands of every person interested in insect life.

Several methods, as already referred to, are employed in the collecting of insects at night, one of which is the simple and ever reliable practice of sweeping by means of the net, so commonly followed by day. This method has previously been recommended, particularly for action on moonlight, chilly or windy nights, though the captures will mainly be the smaller kinds of insects, such as minute flies of the order Diptera, parasites of the order Hymenoptera, and tiny moths of the order Lepidoptera, all of which, nevertheless, deserve attention and careful mounting. Among these little creatures new species are probable. The curious fact has often been observed that after sunset myriads of these little insects can be swept from grass or weeds which in the hot sunshine of the day seemed almost destitute of insect life. A few minutes of sweeping is generally sufficient for gathering enough material to keep the collector busy for hours with the mounting. Usually at twilight or later the grass becomes wet with dew; consequently net and specimens get sticky with moisture; but if the poison bottle is lined inside with blotting-paper, a plan which it is advisable to follow at any time, and not too many specimens put in together, there is little danger of injury to them. As a further precaution, strips of soft paper, such as newspaper, can also be placed loosely in the bottle, to absorb moisture and prevent specimens from shifting and rubbing each other or adhering into masses too large for safety while the bottle is carried.

One blessing, perhaps, for which we ought to be thankful, is that only certain small groups of night insects are musical; if all kinds of insects were as noisy as some examples of the Orthoptera, there is no telling whether a person, unless he was deaf, would be able to sleep in the summer-time. A year ago last summer the following appeared in a local paper:

"KATYDID SANG ALL NIGHT.

"The neighbors in the 700 block on Tennessee street have been greatly annoyed for the past week by a katydid. It would sing all night long, and sang so loud that some thought it must be a tree-toad. All attempts to shake it from the tree proved useless. It was caught last night, and could be termed a giant katydid. It

measured about an inch and a quarter long and had a very large body; its wings were immense, It will be a good specimen for one who is collecting insects." (From Lawrence *Journal*, August 4, 1904.)

On inquiring if the specimen could be obtained, it was learned that chickens had eaten it. However, my disappointment was banished a few nights later when a strong rasping noise was heard issuing from a tree which stood near my home, and as the shrill sounds continued all night it was evident that an accommodating specimen of what was wanted had located there for my benefit. A night or two after, when another songster in another tree began calling also, the conclusion was reached that it was time to make an attempt, at least, to capture one or both of the supposed insects. Provided with lighted lantern and poison bottle, one night, the author climbed the tree, a moderate-sized elm, in which the first fiddler was harbored, and located the fellow by his racket. He was a little cautious as my light approached him and stopped his fiddling, but remained within reach, although attempting to conceal himself among leaves on the under side of a branch. With one well-aimed grab he was secured in my hand and soon reposed safely in my poison bottle. However, his comrade in the other tree, a smaller elm, repeatedly evaded me by climbing out on the tips of branches beyond reach and out of sight. The captured specimen was identified as *Cyrtophyllus perspicillatus* Linnæus, and is now the only example of its species in the collection of the University of Kansas.

Some years ago, while living in Colorado Springs, the business of insect collecting was one night unexpectedly forced upon me. A migration of locusts, the Long-winged grasshopper, known as *Dissosteira longipennis* Thomas, was evidently detracted from flight over or near the city by the electric lights, directly after dark one evening, and the streets soon became covered with the living insects. In seeking every source of light, they invaded open places of business faster than they could be cleared away. They were caught in handfuls and flung into pails of scalding water to end their struggles. The sidewalks and street-crossings of several business blocks were covered so thickly that people walking there would crush a mass of bodies underfoot at every step. Next morning the street cleaners carted off dead grasshoppers by the wagon-load, and for fear another invasion might come, the streets were not lighted for several nights afterward. This phenomenon occurred on Thursday evening, July 21, 1898; and the ridiculous part of the affair was

the claim made in the daily papers that the insects came from Kansas, when, as a matter of fact, the species is more native to the Colorado plains.

Regular methods of night collecting, besides sweeping, depend on two agencies as means of attraction or lure. The principal one is artificial light, as already mentioned; the other some savory bait. Any kind of artificial light, if exposed, attracts insects, but not all insects are attracted by light. A bait, therefore, which allures by scent, and gratifies the insect taste, must be used for those that do not come to light nor can be found by sweeping. The readiness and persistence with which insects generally seek a source of light carry myriads of them to destruction, either by fitful dartings into flames of candles, lamps, and jets, or by onslaught of multitudes in the electric arc lamps. The screening of windows and doors of houses is not only serviceable against day insects, but prevents great annoyance at night from insects which would otherwise freely enter should windows or doors be opened; indeed, many insects are small enough to pass through fine screening. Every person is familiar with the movements of insects in fluttering around a light in a room; at least such as enter in spite of barriers, and cause provocation. In view of such tendencies as these, the collector does not always have to go after his game, for, instead, it comes to him readily; he need not leave his room at times, and nothing more than poison bottles are required in which to catch the specimens. Even some invalids can have the privilege of collecting in this manner.

Wonderful results can be accomplished merely with the aid of a flickering candle-light. My favorite method was accomplished with the use of a lantern supplied only with a candle. With this modest provision, not only was much pleasure derived for myself, but also for my little daughter, who ably assisted me. We would sit out of doors during the summer evenings, either on the porch of the house or in the yard, and together we watched for and captured the insects that were attracted to the light of this simple lantern, which was placed in the center of an open newspaper spread on the floor or ground. The sheet of paper exposed the insects which alighted on it to easy capture. Beetles generally fell on the paper and were picked up in the fingers and dropped into a poison bottle by themselves; they have hard bodies, and make frantic struggles in the bottle before they are subdued by the fumes, and, in consequence, would ruin moths or weaker insects if placed in the bottle together. Tiny moths, parasites and bugs usually alighted on

the glass globe of the lantern, over the surface of which they ran actively, but were captured, one at a time. The open mouth of a poison bottle was dexterously placed over a specimen, confining it against the globe of the lantern until it entered the bottle, which was then quickly closed with the cork held ready in the other hand. Two bottles at least are needed by each person engaging in this process; after a specimen is captured, the bottle should be set aside to allow time for the captive to succumb to the deadly fumes and cease struggling; else, if the bottle is opened too soon, the specimen will escape; meanwhile the other bottle is used for catching a specimen, after which it, too, is set aside, and then the first bottle is used again. Such operations often become quite exciting in efforts to catch exceptional specimens or others that were more or less prized. My little daughter was exceedingly entertained, and many times awaited impatiently for the evening to grow dark enough to begin collecting. Although but nine years old, she has developed quite a knowledge of entomology, and can rattle off big technical names that would perplex the average grown person. Moreover, she has no fear in handling live insects, such as the harmless ones, which are often attentively observed, and besides she has learned to pin up specimens after they are dead as neatly and properly as a professional collector can do. Other children, following the examples of their parents, detest the "crawling things," as they are called, usually with fearful, though needless, abhorrence. Thus, what should provide entertainment and instruction even for children is too generally condemned, and much that could be learned from nature in a simple way is lost. On the other hand, influence once started in the right direction often spreads rapidly. Before very long the neighbors' children had acquired outfits similar to what was provided for my little girl, and their combined excursions in daytime made the vicinity a fateful one for unwary insects, especially butterflies.

The stronger the light the more attractive it becomes to insects; consequently, the electric arc lights on the streets of town or city probably draw insects from long distances. However, collecting at night on the streets or at public places brings a person thus engaged more to notice than in day collecting, when the collector can seek the country. But electric lights cannot be forsaken without a lack of valuable specimens, particularly moths. Therefore, the collector is obliged to take a position directly under the glare of a light, where his movements draw the attention of people passing along the sidewalks. Ofttimes an inquisitive spectator will call

out, "What are catching?" "Insects! What do you catch them for?" "What do you do with the bugs?" and similar questions; while another observer, perhaps, interposes a rude joke. Or a number of boys will suddenly offer their services and pick up every insect that can be found, since many fall on the ground—moths which flutter until their wings are battered or torn beyond recognition, and the commonest kinds of beetles—all of which are promptly presented to the collector with a shout, "Here, mister! here's a bug!" until he is either distracted with importunities and worthless specimens or forced to move to another location and avoid such associates. Two or more persons collecting together with the same interest afford companionship which gives a mutual feeling of relief from arousing undesirable notice which one person would bear alone, but such company is not always possible.

Only net and bottles are needed in visiting lights on the streets. Electric lights are usually hung quite high, though not as high above side streets as on business streets. Rather than carry a long, unwieldly pole as a handle to my net for reaching lights, it is my custom to let the light down as low as desired by releasing the tackle, after the manner of a trimmer; hence, am enabled to reach the hovering insects with my net on an ordinary length of handle. When done with the light, it is raised to usual position. Care should be exercised to keep one or more bottles exclusively for killing moths, which when dead should be turned into a separate bottle for storage; then the collecting bottles can be used for fresh captures, and as the live moths are not allowed to flutter in with the dead specimens, one danger of injury by denuding of wings is avoided.

Sometimes fine specimens may be found on the ground where they alight or fall. The season for favorable collecting at electric lights begins in Lawrence in the first week of May and it may be said to last for fully six months. Whenever a brisk breeze is blowing, insects fly towards the lights on the side facing the wind; as, for instance, if the wind is south, the insects hover in a trail on the north side. The best place for finding insects in greatest numbers at electric lights in Lawrence was found on the river bridge (over the Kansas river), particularly at the south approach, which is somewhat higher than the north end, but whether this slight difference should account for the greater amount of insects appearing at the south end cannot be stated. Here the aquatic neuropteroid forms, such as May-flies and caddice-flies, became most numerous in July and August. The former are very frail insects and cannot

fly far from the water from which they emerge. It is noticed that they always face the wind, whether at rest or in flight, even should they be carried backwards on the wing. Interesting records could be written from observations regarding night insects. Some of these from my notes are as follows:

"July 27.—Slight rain before dark and May-flies were exceptionally thick around the lights. The floor of the bridge was so thickly covered with these insects that their wings gave the effect of snow, while the woodwork along the sides was coated with white molted skins. One kind of May-fly (*Polymitarchys albus* Say), after falling to the floor, seems unable to rise again, and there batters its wings into shreds in the futile endeavor to fly, until too feeble to flutter longer, when it dies from exhaustion. On close examination their legs are found to be rudimentary or aborted, and therefore too weak to enable the insect even to crawl. This kind has been noticed during the entire week."

"July 30.—The very smallest kind of May-flies (*Cœnis diminuta* Walker) are the first to appear at dusk, when they come in great numbers. The larger kinds appear shortly afterwards, and in such multitudes that the electric-light globe soon becomes choked with their bodies, in a mass so densely packed that the light is obscured. At ten o'clock, or soon after, the insects have mostly dispersed."

Remarks to above.—As a rule, good collecting at lights ends about an hour after dark. As soon as darkness settles, the larger insects generally come with a rush to the lights, but they seldom linger in force very late.

"August 1.—On river bridge just after dark. Myriads of small May-flies flying against the wind to the electric light suggested the appearance of a tail to a comet when viewed from a short distance. Very few caddice-flies out."

"August 3. Insects very thick. The frail White May-fly (*Polymitarchys albus* Say) was more abundant than usual, and multitudes literally lay in a compact bed on the floor of the bridge, vainly flopping their wings to pieces in trying to rise. Their egg-clusters were scattered about thickly among their bodies."

"August 5. The common kinds of May-flies were nowise as thick as usual. Found more of the Black caddice-flies than ever before in one evening."

"August 10.—Mostly large moths out. The dead bodies of a considerable number of May-flies were seen sticking by the wings in all sorts of positions to the framework of the bridge, where the

live insects had probably been dashed during a rain-storm of the night before and there left to perish helplessly."

"August 11.—May-flies and caddice-flies somewhat scarce."

"September 21.—On the bill-board near the bridge, the caddice-flies were congregated in numbers, and the noise produced by contact of their bodies as they alighted on the paper was like a continual tapping sound, which first drew my attention."

"October 5 and 6.—On bridge each night between eight and nine o'clock. Nights cool, with full moon shining. Insects were more numerous on these moonlight nights than on dark night preceding. Watching carefully for new species of caddice-fly."

(*Remarks to above.*—This new species was first recognized in my material by Prof. V. L. Kellogg, but it was named by Nathan Banks, from specimens sent to him, as *Hydropsyche kansensis.*)

A favorite location for beetles and moths was found at the light in South park. Here the light was frequently lowered. Wherever game is to be found, there the hunter seeks it. We cannot blame some people who, not knowing about an entomologist's business, may express wonder at his strange actions, particularly if on a street corner at night. But when they begin to question your mental condition, you will probably guard your conduct. A certain party asked a friend: "What is the matter with Mr. T.; is he crazy?" The friend, rather astonished at the question, which seemed to be asked in earnest, replied that Mr. T. had always acted all right; at least he had never done anything strange as far as known; therefore, could not account for such an impression. "Well," the party explained, "he acted very queer the other night. He stood near the lamp-post on the opposite corner of the street and waved and jerked his arms in the air, jumped about on the sidewalk, and ran around the lamp-post several times."

The use of traps in which to catch insects at night, by the allurement of light, is an important method receiving but partial attention. The advantage of a trap is such that, after once rigged up for the night, it "works while you sleep." But next day the work will fall on the collector, who has the catch to pin up. Some traps are so constructed that insects may be allured directly into one, in attempts to reach the light placed inside; another form is arranged to catch insects which fall into it after reaching the light that is openly exposed above it. In any case, however, the insects meet death in a poison jar fixed to receive them, and which is usually charged with cyanide of potassium, although other agents for suffocation, as chloroform, for instance, can be applied.

An outfit of the latter kind was taken and used on a collecting trip for the University of Kansas, under direction of Dr. F. H. Snow, in Hamilton and Morton counties, western Kansas, June, 1902. A large street lantern was furnished to supply the light, and the collecting device consisted of a gigantic funnel, made of heavy tin, painted outside, but left bright and smooth inside, and it converged into a receiver, about the size of a large fruit-can, which could be opened by withdrawal of the bottom in order to allow a cyanide jar to be inserted at time of beginning operation for the night, and to be removed and emptied in the following morning. A tripod of rough poles was erected as a support for the funnel, with the lantern hanging directly over its mouth. Our experience in using this outfit has been related in the account of the expedition, published by the author in the *Kansas Farmer* of December 4, 1902, from which the following is quoted:

"Also, every night the large lantern was lighted and the big funnel hung underneath to trap the insects which fell into it. The light from the lantern served to illuminate the camp finely, though only on one night did it pay as an attraction for insects, but at this time its returns were immense, probably due to a lull and change of wind, which afforded the right condition for insects to fly. Moths and beetles appeared in continuous swarms and fluttered in the circle of light, numbers of them falling into the funnel or onto the ground, and the doctor hastily called out all hands to capture them. Care must be exercised always to prevent injury in catching the delicate creatures; but here the great number of beauties which fluttered in sight nearly drove the doctor to distraction for fear their perfect condition would be marred by beating their wings against the sides of the funnel or on the ground as they endeavored to regain their flight. He groaned aloud, as if the sight of so many prizes gave him a pain, being unable to catch every one that he wanted. Really, the party presented a comic, as well as an animated, scene; the effect of the members in prancing around the lights, whirling nets frantically in the air, or in searching the ground for choicest specimens of the fallen hosts, amid a din of excited exclamations, mingled with the doctor's groans, would have afforded an entertainment for an audience. All efforts were fully repaid at last, for the poison bottles became crammed to the limits with the catches, and the whole party was thoroughly tired before the supply showed signs of failing."

I might mention, however, that the camp was located at the

edge of a thicket along the bank of the Arkansas river, a few miles east of the town of Coolidge.

The danger of specimens injuring themselves is quite well prevented in the box-trap, designed on the plan as mentioned for direct entrance to enclosed light. The width of opening into the trap depends on the space allowed between the edges of two inclined panes of glass which guard the front of the trap. They can be set as desired. For Microlepidoptera, the aperture was narrowed so that anything large enough to do damage could not enter with these tiny and extremely delicate moths. The box was made of heavy tin, painted outside to prevent rusting, but left bright within. An oil lamp was placed at the back end, which is partitioned by a pane of glass from the inner chamber, where the insects are allured by the light shining through to the front. In the bottom of the interior an opening is cut to permit the insects to drop into the poison jar, a Mason pint, which is held in place by a screw ring, made by the center being cut out of a cap, thus providing easy attachment or removal of the jar from beneath. The jar should be strongly charged with poison, since it must remain open when in use, and, for this reason, insects do not die as quickly in it as they would in a closed bottle; hence, if fumes become weak, the captures are liable to flutter too long before they die and mar their wings, as well as of others which they beat. In daytime, after being removed and emptied, the jar will regain strength if closed with a tight cap, or it can be used for storage purposes, or, in a pinch, to kill extra large insects. The price of this trap was five dollars complete.

During the past summer, this trap was used on two trips taken for the University of Kansas, under direction of Dr. F. H. Snow—one to Brownsville, Tex., and the other to Douglas, Ariz. Fully 8000 moths and butterflies were collected at the two places, comprising more specimens of the order Lepidoptera than had ever been caught in any season preceding, and the majority of these were Microlepidoptera, which have required months of work for the spreading of their wings. The use of the trap contributed in a great measure towards this successful collecting.

Besides, hand collecting was engaged in to a large extent in camp. At night, a lighted lamp was set on the camp-table placed in front of the tent where the light shone on the canvas drawn behind it, thus presenting an illuminated screen on which the insects settled in numbers, and from which position, they were easily captured directly into poison bottles. The tiniest moths could be

obtained in this manner in the most perfect condition by careful mode of capture—one specimen being caught at a time, when the bottle was set aside until the insect became stupefied; then the specimen was transferred into a stock bottle. Provided with several bottles, a person could work rapidly for hours into the night, and remain comfortably seated at a table, with equipment and specimens before him.

Only one other method for night work remains to be treated of here, and that is the common practice known as "sugaring." It depends on the use of a bait alluring by scent and tempting to the taste. As mentioned, not all night insects come to light. The wood moths, belonging to the genus *Catocala*, for instance, are only rarely caught in any other way than by sugaring. They are found in secluded thickets or thick woods, which are rather lonesome places for night work. Besides for the sake of company, two persons can work together to better advantage than one alone. The bait is commonly made by mixing beer and molasses, or instead of beer vinegar can be used; and the most effective results are obtained when either or both the beer and molasses are stale and strong-smelling. The mixture is smeared by means of a dauber on trunks of trees and stumps, on logs, or even fence-posts, beginning directly after dark, when the course of operations can be selected with the light of an open lantern. But for inspection purposes, after intervals of about fifteen minutes, a dark lantern, or light otherwise shielded from the person carrying it, is required. Moths, beetles and other kinds of insects are found feeding greedily on the mixture by the collector, who approaches cautiously, with his light thrown on the smeared spots before him. Slowly an open poison bottle is pushed towards a specimen, in case it is a moth, until quite close, when it is quickly clapped over the insect, thus confining it within. Keep the bottle pressed against the tree until, at a favorable moment, the free hand can be thrust over the mouth, and then the cork may be carefully inserted as the fingers slide out of the way. Beetles are generally picked up in the fingers by a quick movement and dropped into poison bottles. In all these matters, practice counts for more than instruction.

ADDITIONS TO THE LIST OF KANSAS ARACHNIDA.

By THEO. H. SCHEFFER, Manhattan.

IN his "Preliminary List of Kansas Spiders," published in volume XIX of the Transactions of the Kansas Academy of Science, the writer recorded 100 species taken within the borders of the state, and expressed the desire to double the list in another season's collecting. But forty-three additional species of spiders have been taken, up to date, however. These are listed in the present paper, together with a preliminary report on other groups of the Arachnida represented in our state.

Four species of spiders new to science are described and figured in this paper. Several other single specimens probably represent new species, but it is not the policy of the writer to describe from a single specimen. To merit description, a supposedly new type should be fairly well represented in some locality.

The forty-three species herein listed represent eleven families and twenty-nine genera. Three of the families and seventeen of the genera were not included in the first list. All summed up, then, we have recorded from Kansas 143 species of spiders, representing 16 families and 67 genera.

The illustrations for this paper were by Miss Ella Weeks.

Types of the new species are in the Kansas Agricultural College collection and in the National Museum, at Washington.

ORDER *ARANEIDA*.

Family ATYPIDÆ.

Brachybothrum robustum Simon.

Brachybothrum robustum Simon. Actes Soc. Linn. Bord., vol. 44, p. 7.

Two males from Manhattan, April 5, and an immature female from Delphos, August 5.

Family ULOBORIDÆ.

Uloborus plumipes Lucas.

Uloborus plumipes Lucas. Explor. d'Algerie Anim., art. I, p. 252.

Two females taken in webs with cocoons at Manhattan, July 14. Immature male from St. George, June 6.

Hyptiotes cavatus Hentz.

Cyllopodia cavata Hentz. Jour. Bost. Soc. Nat. Hist., V, 1845, p. 466.

The Triangle spider is apparently rare in Kansas. A single specimen was found at Three-Mile Hill, near Manhattan, October 10.

Family THOMISIDÆ.

Xysticus texanus Banks.

Xysticus texanus Banks. Journ. N. Y. Ent. Soc., XII, 1904, p. 112.

Two females of this prettily marked spider in a collection made at Delphos August 5.

Xysticus graminis Emerton.

Xysticus graminis Emerton. Trans. Conn. Acad., VIII, 1892, p. 364.

A male of this species from Manhattan, May 5.

Ebo latithorax Keyserling.

Ebo latithorax Keyserling. Neue Spinn. aus Amer., V, 1883, p. 678.

Adults of this species have not been observed, but the young were taken in considerable numbers in sweeping at Manhattan, October 11.

Philodromus rufus Walckenaer.

Philodromus rufus Walckenaer. Ins. Apt., I, 1837–'47, p. 555.

Several specimens collected at Minneapolis June 30.

Philodromoides, gen. nov.

Cephalothorax low, about as wide as long; head region much narrowed and slightly elevated. Abdomen fully twice as long as wide, very little wider behind than at the base; somewhat pointed at the end; the base projects a short distance over the cephalothorax, and is distinctly notched on the upper side. The sternum and labium are about as in Philodromus. All eyes approximately equal in size; the anterior row much the shorter and slightly recurved; median eyes of this row farther from each other than from the side eyes. Posterior row also recurved; side eyes of this row on larger tubercles than any of the others; median eyes farther from each other than from the side eyes. Ocular quadrangle considerably wider behind; about as wide as long. Clypeus wider than space between anterior median eyes, but not as wide as space between posterior median eyes; obliquely directed forward and downward. Legs long and slender, the second pair longest, the third shortest; the relative lengths are, in their order, second pair, first pair, fourth pair, third pair. The tibiæ of the first and second pairs are set beneath with ten or twelve stout spines arranged in two rows, and the metatarsi are similarly armed with half that number. Weaker spines likewise occur on the other two pairs of legs and on the pedipalps.

Philodromoides prataria, sp. nov. (fig. 10).

FEMALE.—Length, 6 mm.; length and width of cephalothorax, 2 mm.; width of abdomen, 2 mm. Other characters as given in the generic description. A very few short, bristle-like hairs scattered about among the spines on the outer joints of the legs and on the cheliceræ and the pedipalps; thickest on the tarsi of the latter.

COLORATION.—Abdomen plain brown above, mottled and streaked with a lighter shade. The four muscle impressions are quite distinct. Cephalothorax rusty brown, lighter at the sides and just back of the head region. Streaks marked by depressed lines radiate from the dorsal groove. The sternum is pale yellow or almost white. The abdomen is lighter beneath than above, and there is a less mottled central region, set off by a row of indistinct dots on either

side. The legs are pale yellow to whitish. The femora, patellæ and tibiæ of all four pairs are marked in front with a longitudinal stripe of black, which becomes neatly obliterated on the metatarsi and tarsi. The corresponding joints of the legs of the third and fourth pairs are similarly marked on the hind border also. The males are somewhat smaller than the females, the abdomen being considerably narrower than the cephalothorax. The legs are more hairy in appearance and the spines less conspicuous than in the female. The color markings are about the same in the two sexes. This species is not uncommon about Manhattan, Kan., in midsummer. Mature males and females were taken in this locality on August 17.

Family CLUBIONIDÆ.

Castaneira crocata Hentz.

Herpyllus crocatus Hentz. Jour. Bost. Soc. Nat. Hist., V, 1845, p. 457.

Representatives of this species from Wallace, August 20, and from Manhattan, July 29. From its general appearance and movements this spider might, at first sight, be easily mistaken for a velvet ant (mutillid).

Trachelas tranquilla Hentz.

Clubiona tranquilla Hentz. Jour. Bost. Soc. Nat. Hist., V, 1845, p. 450.

One female taken in collecting under stones at Lawrence October 8.

Family DRASSIDÆ.

Zelotes decepta Banks.

Prosthesima decepta Banks. Proc. Acad. Nat. Sci. Phila., 1900, p. 531.

A single male specimen from Manhattan, May 5.

Zelotes rufula Banks.

Prosthesima rufula Banks. Proc. Acad. Nat. Sci. Phila., 1892, p. 17.

A single female specimen from Manhattan, May 5.

Melanophora atra Hentz.

Herpyllus ater Hentz. Jour. Bost. Soc. Nat. Hist., V, 1845, p. 455.

Two females from Manhattan, May 1.

Gnaphosa sericata Koch.

Herpyllus bicolor Hentz. Jour. Bost. Soc. Nat. Hist., V, 1845, p. 456.

One female from Manhattan, July 27.

Family SALTICIDÆ.

Phidippus pius, sp. nov. (figs. 1, 2, 7).

A medium-sized species, rather light in color. One male taken at Manhattan in October and two females in July.

MEASUREMENTS.—Length of female, 9–10 mm. Length of abdomen, 5 mm; width of abdomen, 3 mm. Width of cephalothorax about the same as that of abdomen. The measurements of the male are very approximately the same, except that the abdomen is slightly narrower.

LEGS.—Relative length, female, 4, 1, 2, 3; male, 1, 4, 2, 3. The legs of the first pair are considerably stouter than any of the others. First and second metatarsi set beneath with six stout spines in two rows. Tarsi of same legs with four spines. A few spines, less regularly placed, on the other legs also.

COLORS.—Female pale yellow beneath, without markings. Very much the same above, except for a dark area occupying the ocellar quadrangle and two narrow, dark colored streaks, one on either side of the median line of the abdomen. The latter are not at all distinct on the anterior third of the abdomen. Two or more pairs of white spots dot these dark streaks. The ground color of the male is somewhat darker, shading into orange brown on the cephalothorax and legs. Like the female, the male is unmarked beneath and has, above, the two dark streaks on the abdomen and the dark area on the ocellar quadrangle. The femora and, to a certain extent, the other joints of all the legs are more or less streaked or almost banded with very dark brown. The tips of the tarsi in both sexes are dark. Palpal organs of the male dark except at the tip. Other joints of the palps pale and unmarked. The body and legs of both sexes are sparsely covered with long, silky hairs, with here and there a spine.

Phidippus texanus Banks.

Phidippus texanus Banks. Proc. Ent. Soc. Wash., 1905.

Not uncommon in the late summer and the autumn months. Specimens taken at Englewood and Medora in July, and at Manhattan in October.

Phidippus multiformis Emerton.

Phidippus multiformis Emerton. Trans. Conn. Acad., VIII, 1891, p. 6.

Two females and one male from Manhattan, July 27.

Phidippus montivagus Peckham.

Phidippus montivagus Peckham. Trans. Wis. Acad., XIII, p. 293.

A single specimen, female, from Manhattan, July 14.

Dendryphantes glacialis, sp. nov. (figs. 3, 4, 8).

An average-sized species, conspicuously striped on the abdomen. Two females were taken at Manhattan May 26, and a pair in the glacial region near St. George June 6.

MEASUREMENTS.—Female, 5.5 mm., male, 5 mm. in length. Cephalothorax, 2.5 mm. long, 2 mm. wide.

COLORS.—The cephalothorax of this species is reddish brown, with scattering white hairs thick enough at the sides and on the posterior slope to almost give the appearance of a band or stripe. About the eyes the red-brown is several shades darker. The ground color of the abdomen is dirty white tinged with yellow. Down the median line is a brown stripe, a little the wider in the male. On either side of this stripe is another of the same color and approximate width, curving a little to conform to the lateral border of the abdomen. Still another and wider stripe, not visible from a dorsal view, runs along each side of the abdomen. In the female this stripe is broken into spots or streaks. On the ventral surface there is a narrow median stripe from the genital opening to the spinnerets, and a wider stripe each side of this. The legs and palps are dull yellow tinged with brown, unmarked in the female, but much darker with some appearance of banding in the male. The front row of eyes is curved, with the middle eyes fully twice as large as the lateral, and almost as widely separated as the former and latter.

Dendryphantes militaris Hentz.
Attus militaris Hentz. Jour. Bost. Soc. Nat. Hist., V, 1845, p. 201.
Not so common as D. capitatus. Specimens taken at Manhattan in October.

Pellenes cognatus Peckham.
Pellenes cognatus Peckham. Bull. Wis. Nat. Hist. Soc., I, 1901, p. 224.
One specimen, a female, from Arkalon, July 21.

Peckhamia picata Hentz.
Synemosyna picata Hentz. Jour. Bost. Soc. Nat. Hist., V, 1845, p. 370.
A pair of these ant-like spiders taken at Manhattan October 10. Neither sex was quite mature.

Mævia vittata Hentz.
Attus vittatus Hentz. Jour. Bost. Soc. Nat. Hist., V, 1845, p. 360.
Fairly common. Mature specimens taken at St. George June 6, and at Manhattan in October.

Thiodina sylvana Hentz.
Attus sylvanus Hentz. Jour. Bost. Soc. Nat. Hist., V, 1845, p. 364.
A male of this species from St. George, June 6.

Wala palmarum Hentz.
Epiblemum palmarum Hentz. Jour. Bost. Soc. Nat. Hist., V, 1845, p. 366.
Three males in material collected at Lawrence October 8.

Family ARGIOPIDÆ.

Araneus aculeatus Emerton.
Epeira aculeata Emerton. Bull. U. S. Geol. Surv. Terr., III, 1877, p. 528.
One specimen, a female, from Clark county, June 15.

Araneus trifolium Hentz.
Epeira trifolium Hentz. Jour. Bost. Soc. Nat. Hist., V, 1845, p. 471.
This large orb-weaver is represented in the college collection by a single specimen, female, taken at Manhattan August 22.

Araneus displicatus Hentz.
Epeira displicata Hentz. Jour. Bost. Soc. Nat. Hist., V, 1845, p. 476.
One male from St. George, June 6.

Araneus mormon Keyserling.
Epeira mormon Keyserling. Die Spin. Am., vol. IV.
A few specimens taken in provision stores of mud-dauber wasps at Meade July 18.

Acacesia foliata Hentz.
Epeira foliata Hentz. Jour. Bost. Soc. Nat. Hist., V, 1845, p. 475.
One female taken in sweeping at Lawrence September 8.

Mangora placida Hentz.
Epeira placida Hentz. Jour. Bost. Soc. Nat. Hist., V, 1845, p. 475.
One female from Manhattan, May 2. Several males, lacking one moult of maturity, collected at Lawrence October 10.

Singa nigripes Keyserling.
Singa nigripes Keyserling. Verh. d. z. b. Ges. Wien, 1883, p. 655.
The species is fairly common in some localities. Specimens from St. George, June 6.

Family LYCOSIDÆ.

Lycosa gracilis Banks.

Lycosa gracilis Banks. Proc. Acad. Nat. Sci. Phila., 1892, p. 70.

A male from Manhattan, May 20.

Lycosa punctulata Hentz.

Lycosa punctulata Hentz. Jour. Bost. Soc. Nat. Hist., IV, 1842, p. 390.

A mature female of this moderately large species from Manhattan, October 6.

Lycosa rufiventris Banks.

Lycosa rufiventris Banks. Proc. Acad. Nat. Sci. Phila., 1892, p. 65.

Not uncommon. Specimens taken at Manhattan in October and April.

Lycosa permiana, sp. nov. (figs. 5, 6, 9).

A medium-sized spider, not uncommon in the spring and early summer. It hides among stones at some distance from watercourses.

MEASUREMENTS.—Female, about 15 mm. in length; male, 10-11 mm. Cephalothorax of female, 6 mm. long, 4.5 mm. wide; moderately arched, the highest point being about midway between the posterior eyes and the front of the dark line marking the dorsal groove. First leg, 14 mm.; fourth leg, 18 mm.

COLORS (in alcohol).—The ground color of both sexes is light yellow. In the male the abdomen is streaked and spotted with black above and brown below. In the female the similar markings of the abdomen are brown, both on the dorsal and the ventral surfaces. The ground color of the abdomen in this sex is sometimes more nearly dirty white than yellow. The markings of the cephalothorax are alike in the two sexes—a rich brown on the sides of the head and in the region traversed by the depressed lines radiating from the dorsal groove. The top of the head, or highest portion of the cephalothorax, is yellow. It is marked posteriorly by a pair of brown spots. A dark line marks the dorsal groove. The legs are light yellow, unmarked, but tinged with a suggestion of brown in places, especially on the distal joints. Numerous long, dark spines and a sparse covering of dark hairs tend to obscure the ground color of the legs. The coxæ and the sternum are brownish. The tarsi of the male palps are dark brown. Lycosids of this species collected at Manhattan in April and at Delphos in May. Both sexes mature at this time.

Pardosa texana Banks.

Pardosa texana Banks. Jour. N. Y. Ent. Soc., XII, 1904, p. 115.

One specimen, a female, from Englewood, August 8.

Pardosa milvina Hentz.

Lycosa milvina Hentz. Jour. Bost. Soc. Nat. Hist., IV, 1842, p. 392.

One lycosid of this species from Meade, July 18.

Family AGELENIDÆ.

Cicurina arcuata Keyserling.

Cicurina arcuata Keyserling. Verh. d. z. b. Ges. Wien, 1887, p. 460.

Two specimens, a male and a female, taken at Manhattan, May 5.

Hahnia agilis Keyserling.

Hahnia agilis Keyserling. Verh. d. z. b. Ges. Wien, 1887. p. 465.

One specimen from Manhattan, April 15.

Family MIMETIDÆ.

Mimetus interfector Hentz.

Mimetus interfector Hentz. Jour. Bost. Soc. Nat. Hist., VI, 1850, p. 32.

A female of this species taken in sweeping at Minneapolis June 30.

Family THERIDIIDÆ.

Theridion puncto-sparsum Emerton.

Theridion puncto-sparsum Emerton. Trans. Conn. Acad., VI, 1882, p. 12.

Found occasionally at Manhattan. Specimens taken in July.

Theridion differens Emerton.

Theridion differens Emerton. Trans. Conn. Acad., VI, 1882, p. 9.

One specimen from Manhattan, May 26.

ORDER *SCORPIONIDA.*

Family CENTRURIDÆ.

Centrurus carolinianus Beauvois.

This seems to be the only species in the state. It is common under loose stones in limestone regions, and is less frequently met with under sandstone or loose bark in other localities. Specimens were taken at various times of the year in the following counties: Douglas, Pottawatomie, Riley, Ottawa, Russell, Smith, Clark, Barber, and Morton.

ORDER *PSEUDOSCORPIONIDA.*

Family CHELIFERIDÆ.

Chelifer cancroides Linnæus.

This species is found in almost any part of the United States. We have, in the college collection, specimens from Lawrence, Manhattan, and Sun. Most of them were taken under bark.

ORDER *SOLPUGIDA.*

Family SOLPUGIDÆ.

Eremobates pallipes Say.

These curious arachnids are not uncommon in the western and southwestern parts of the state. They are nocturnal in habit, and during the day are usually found under stones or cattle chips. Specimens have been secured in Wallace, Seward, Clark and Morton counties. But one Kansas species is known.

ORDER *PHALANGIDA.*

Family PHALANGIDÆ.

Liobunum vittatum Say.

Phalangium vittatum Say. Am. Ent., Lec. ed., vol. II, p. 13.

This is the common "daddy-long-legs" found in most parts of the United States. It includes Say's L. dorsatum, the more northerly type of the species. Abundant in the central and eastern portions of the state, but only occasionally met with in western and southwestern Kansas. Specimens from Delphos, Manhattan, and Lawrence, August to October.

Trachyrhinus favosus Wood.

This species supplants L. vittatum in the southwestern part of the state. It frequents the sage-brush particularly, resembling this vegetation so closely in color that the collector is not likely to see it unless it is in motion. One specimen was taken at Manhattan, and numerous others at Englewood, Coldwater, Arkalon, and Sun, July to October.

Mesosoma niger Say.

Phalangium nigrum Say. Am. Ent., Lec. ed., vol. II, p. 14.

One specimen from Manhattan, October 15. Others taken at Sun and Coldwater in the middle of July.

Family COSMETIDÆ.

Cynorta sayii Simon.

Our representative of this family is fairly common in the eastern part of the state. It is the brownish-red phalangid, found singly, or, in the winter, in clusters under loose stones. Specimens collected at various times of the year in the vicinity of Manhattan, St. George, and Lawrence; one specimen from Sun.

EXPLANATION OF FIGURES.

Fig. 1. Phidippus pius. Female × 4.
Fig. 2. Phidippus pius. Male × 4.
Fig. 3. Dendryphantes glacialis. Male × 7.
Fig. 4. Dendryphantes glacialis. Female × 7.
Fig. 5. Lycosa permiana. Male × 3.
Fig. 6. Lycosa permiana. Female × 3.
Fig. 7. Epigynum of Phidippus pius.
Fig. 8. Epigynum of Dendryphantes glacialis.
Fig. 9. Epigynum of Lycosa permiana.
Fig. 10. Philodromoides prataria. Female × 5.

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 5.

Fig. 6.

Fig 7.

Fig. 8

Fig. 9.

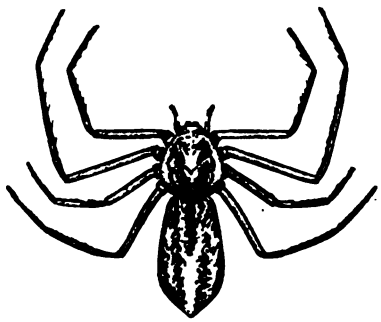

Fig. 10.

THE RED PHALAROPE (Crymophilus fulicarius Linn.) A NEW BIRD FOR THE KANSAS LIST.

By L. L. DYCHE, University of Kansas, Lawrence.

THERE are three species of small shore birds somewhat resembling snipes or sandpipers that belong to the family Phalaropodidæ or phalaropes. The word *phalaropus* means coot-footed (*Phalaris*, the coot, and *pous*, foot). The phalaropes were called coot-footed from the scalloped membrane or flaps on the toes, which resemble those on the coots and grebes.

Wilson's phalarope (*Steganopus tricolor*) is confined during the breeding season to the interior regions of temperate North America. In migration it is said to go as far south as Brazil and Patagonia. It is rather common during the migratory season in Kansas. As a rule, I see a few flocks of these birds every year about the first week in May in the neighborhood of Lakeview, five miles northwest of Lawrence. In June, 1886, Col. N. S. Goss found three pairs of these birds breeding in Meade county. It may be said to breed from southern Kansas north as far as the Saskatchewan regions.

The Northern phalarope (*Phalaropus lobatus*) breeds in boreal regions, but migrates as far south as the tropics in winter. Colonel Goss reports, in his "Birds of Kansas," that he saw a flock of as many as fifteen in Wallace county, Kansas, May 25, 1883. The writer found the birds breeding on the coast of Greenland, and secured specimens at Holsteinborg and Jacobshaven in June, 1895. The nest was a little form in the wet moss near the edge of an ice river.

The Red phalarope (*Crymophilus fulicarius*) belongs to the northern part of the northern hemisphere. It might be described as circumpolar in its distribution. It breeds in the arctic regions north of the sixty-eighth parallel. It migrates south in winter as far as the middle states. I saw specimens at Jacobshaven and Disco island, on the coast of Greenland, in 1895.

A young female Red phalarope was killed at Lakeview, five miles northwest of Lawrence, November 5, 1905, by E. E. Brown, of the University. The bird was flushed from grass and weeds that grew in shallow water. It was the only bird of the kind seen, and, so far as I know, is the first one ever observed in the state of Kansas.

As the Red phalarope is a maritime bird, breeding on the shores of northern bodies of salt water, and spending most of its time on the ocean, its appearance in Kansas was unlooked for. The one taken must, for the present at least, be looked upon as a straggler. It may have been carried out of its usual course by a storm, or may have fallen in company with other birds that go far inland.

In May, 1895, several flocks of phalaropes were seen by the writer, on the ocean between New York and Holsteinborg, Greenland. Many flocks were seen on the return trip, in September, from north of Disco island, to St. Johns, Newfoundland. It was not possible to tell from the ship whether the birds were Red or Northern phalaropes; perhaps both species were seen. Many of them were far out to sea, where no land was visible. They were usually in bunches of from a dozen to perhaps a hundred. They were either flying close to the water, just missing the tops of the waves, or were resting on the water, floating high, as if they possesssed almost no weight.

NOTES ON SOME MOSQUITOES OF DOUGLAS COUNTY.

By CHAUNCEY OVERMAN, University of Kansas, Lawrence.

TOWARDS the latter part of the month of September, 1905, mosquitoes became so exceedingly numerous that the daily papers referred to the "plague of mosquitoes." This condition was due to the excessive rainfall and the warm weather which prevailed throughout the month, conditions favorable to rapid propagation.

At the suggestion of Professor Hunter, several hundred were collected, with a view of ascertaining the proportion of the *Anopheles* or malaria-carrying genus. Of the total number collected, 150 were selected as representative, and were classified. All the specimens were taken within two miles of the University and within about the same distance of the Kansas river. The majority taken were on rather low ground, although they were quite plentiful on the University campus. About twenty per cent. were taken in bedrooms. Most of the collecting was done with a cyanide bottle, although a net was used on a few occasions. The period of collection was from September 20 to December 6.

During the early part of the season the proportion of males was not more than five per cent., but after the first of November it increased to fully thirty per cent. The distribution as to sex was as follows:

Males,	19	12.66 per cent.
Females,	131	87.33 "
Total ...	150	100.00 per cent.

Distribution as to genus was as follows:

Anopheles, 21	14 per cent.
Culex, 129	86 "

The number of species was distributed as follows:

Genus CULEX.

C. pipiens Linn., 73	48.66 per cent.
C. sollicitans Walk., 15	10.00 "
C. consobrinus Desv., 13	8.66 "
C. inconspicuous Grossbeck, 7	4.63 "
C. restuans Theob., 5	3.00 "
C. territans Walk., 5	3.00 "
C. melanurus Coq., 4	2.40 "
C. tarsalis Coq., 2	1.20 "
C. perturbans Walk., 2	1.20 "
C. stimulans Walk., 1	.60 "
C. impiger Walk., 1	.60 "
C. signifer Coq., 1	.60 "

Genus ANOPHELES.

A. maculipennis Meig., 3..... 2.00 per cent.
A. punctipennis Say, 18..... 12.00 "

Genus CULEX.

C. pipiens Linn. Fifty-nine males, fourteen females.
This is a medium-sized brown mosquito, and by far the most numerous form in this vicinity. It is found indoors more often than any other. It does not seem to be so susceptible to cold, as it is common several weeks after frost.

C. sollicitans Walk. Twelve females, three males.
A rather large mosquito, with conspicuously banded legs. It is found on high and on low ground and indoors. It is a hard biter, especially after night. It is a quite common species during warm weather, but disappears with frost.

C. inconspicuous Grossbeck. Seven females.
About the size of C. pipiens, but is quite yellowish. Taken on high ground.

C. consobrinus Desv. (C. inornatus Will.) Twelve females.
A brown mosquito, resembling C. pipiens but distinguished from it by the greater length of the petiole of the first submarginal cell. It is much more common on high ground than on low. It is hard to take with a cyanide bottle, and I have never observed it to bite. It is found after frost. C. consobrinus is the same as specimens in the University museum labeled C. inornatus.

C. restuans Theob. Five females.
This mosquito much resembles C. pipiens, but has two white dots on the shoulders. It is described by Smith sometimes as having a U-shaped mark on the posterior portion of the thorax, but I have never observed this. Felt, in Bulletin 79 of New York State Museum, states that the dots on the shoulders are also variable.

C. territans Walk. Three females.
A small, blackish mosquito, with unbanded legs. Found only on low, swampy ground during warm weather.

C. melanurus Coq. Four females.
A medium-sized species, dark brown in color, the segments of the abdomen unbanded or but very slightly at their base. The three posterior segments always unbanded.

C. tarsalis Coq. Two females.
A medium-sized brown mosquito, with banded legs. Taken on University campus early in October. Habits unknown.

C. perturbans Walk. Two females.
A rather small, dark mosquito, the dark scales on the wings giving them a clouded appearance. Taken last week in October. Habits unknown.

C. stimulans Walk. (C. cantans Coq.) One male.
A brown mosquito, having the basal bands of the tarsi very wide. Taken in September.

C. impiger Walk. One male.

A small, dark form. Wings long and narrow. Taken October 15, on swampy ground,

C. signifer Coq. One female.

A medium-sized black mosquito. The shoulders are marked by longitudinal white lines; legs deep black, contrasting sharply with the white bands. Wings covered with about equal number of white and black scales.

Genus ANOPHELES.

A. punctipennis Say. Two males, sixteen females.

The most common malaria mosquito. They were found most abundantly along a ravine, near which was the only house in the city having severe cases of malaria. They are the hardiest species of mosquitoes, being found indoors and on the sunny sides of buildings as late as December 6. The wings are heavily marked with black.

A. maculipennis Meig. Three females.

This mosquito is not at all common. It may be distinguished from A. punctipennis by the wings being almost clear and marked by four distinct black spots.

SOME RESULTS OF THE UNIVERSITY OF KANSAS ENTOMOLOGICAL EXPEDITIONS

To Galveston and Brownsville, Tex., in 1904 and 1905.

By F. H. SNOW, University of Kansas, Lawrence.

THE writer conducted two entomological expeditions to Texas for the museum of the University of Kansas in the years 1904 and 1905. Each of these expeditions had Brownsville, the extreme southern point of the state, as its objective point, but on account of the wretched connections with the one lone steamer between Galveston and our destination, as well as the limited time at our disposal, we spent the three weeks of our first stay, in May, at Galveston, but succeeded in reaching our original destination by rail in 1905, by the new Gulf Coast line. We remained at Brownsville from June 6 to July 8, encamped within a mile of the post-office, beside the estuary, or old bed of the Rio Grande, which forms a part of the dividing line between the United States and Mexico. The entire collecting period of the two trips was seven and a half weeks.

My associates at Galveston were my regular museum assistant, Mr. E. S. Tucker, and a postgraduate student in entomology, Dr. Charles F. Adams, the well-known dipterologist. At Brownsville I was assisted by Mr. Tucker and an undergraduate student, Mr. E. G. Corwine. The success of the two expeditions was largely due to the efficient cooperation of these gentlemen.

This paper contains lists of the species collected in the orders of Lepidoptera, Coleoptera, and Hemiptera-heteroptera. Lists in the other orders of insects will be published at a later date.

I.—LIST OF LEPIDOPTERA.

Grateful acknowledgments are hereby tendered to Dr. Henry Skinner, Prof. John B. Smith and Mr. W. D. Kearfott for important aid in the determination of species.

The numbers and nomenclature are those of Smith's check-list of 1903.

Abbreviations: B. for Brownsville; G. for Galveston.

Family NYMPHALIDÆ.

2 Danais berenice Cram. B.
8*a* Colænis delila Fabr. B.
10 Euptoieta claudia Cram. B.

122 Phyciodes phaon Edw. B. and G.
131 picta Edw. B.
137 Synchloe lacinia Geyer. B.
139 Cystineura amymone Men. B.
160 Junonia cœnia Hbn. B. and G.
164 Eunica monima Cram. B.
171 Timetes chiron Fabr. B.
183 Apatura celtis Bd. & Lec. B.
185 leilia Edw. B.
188 flora Edw. B.
204 Neonympha sosybius Fabr. B.

Family LIBYTHEIDÆ.

255*a* Libythea bachmani Kirtl. B.

Family ERYCINIDÆ.

263 Calephelis cænius Linn. B. and G.
267 Caria melicerta Schaus. B.

Family LYCÆNIDÆ.

283 Thecla melinus Hbn. B.
361 Lycæna couperii Grt. B.
390 hanno Stoll. B. and G.
393 exilis Bdv. G.

Family PAPILIONIDÆ.

402 Pieris monuste Linn. B.
407 protodice Bd. & Lec. B. and G.
409 rapæ Linn. G.
411 Nathalis iole Bdv. G.
438 Colias eurytheme Bdv. G.
446*a* skinneri Barnes. G.
458 Terias lisa Bdv. B.
458*a* alba Strck. B.
459 linda Edw.? B.
479 Papilio polyxenes Fabr. B.
487 thoas Linn. B.

Family HESPERIDÆ.

495*a* Copæodes procris Edw. B. and G.
532*a* Pamphila huron Edw. G.
535 phylæus Dru. B. and G.
536 brettus Bd. & Lec. B.
538 draco Edw. G.
564 errans Skinner. G.
588 osyka Edw. B. and G.
Pyrgus occidentalis Skinner. New species. B. and G.
649 Pholisora catullus Fabr. B and G.
653 hayhurstii Edw. B.
657 Achlyodes thraso Westw. B.

Family SPHINGIDÆ.

921 Ællopos tantalus Linn. B.
729 Deilephila lineata Fabr. G.
755 Phlegethontius carolina Linn. G.

Family CERATOCAMPIDÆ.

829 Adelocephala heiligbrodtii Harv. B.

Family SYNTOMIDÆ.

854 Pseudomya minima Grt. G.
866 Ctenucha venosa Wlk. B.

Family LITHOSIIDÆ.

894 Illice subjecta Wlk. B.

Family ARCTIIDÆ.

930 Eubaphe aurantiaca Hbn. B.
930a rubicundaria Hbn. G.
932 Utetheisa bella Linn. G.
950 Estigmene acræa Dru. G.
957 Diacrisia virginica Fabr. G.
994 Apantesis vittata Fabr. G.
996 phalerata Harris. B. and G.

Family AGARISTIDÆ.

1066 Copidryas gloveri G. & R. G.

Family NOCTUIDÆ.

1228 Crambodes talidiformis Gn. B.
1229 Platysenta videns Gn. B. and G.
1253 Caradrina subaquila Harv. B.
1278 Oligia chalcedonia Hbn. B.
1284 nucicolora Gn. B.
1449 Prodenia ornithogalli Gn. G.
1452 Laphygma frugiperda S. & A. G.
1640 Peridroma incivis Gn. B.
1728 Feltia annexa Tr. B. and G.
2164 Leucania subpunctata Harv. G.
2184 juncicola Gn. G.
2502 Heliocheilus paradoxus Grt. G.
2504 Heliothis armiger Hbn. G.
2513 Rhododipsa volupia Fitch. G.
2558 Schinia lynx Gn. G.
2688 Plusiodonta compressipalpis Gn. G.
2711 Autographa pseudogamma Grt. B.
2762 Ogdoconta cinereola Gn. B. and G.
2764 Pæctes declinata Grt. B.
2775 Amyna orbica Morr. B.
2777 Aletia argillacea Hbn. B.
Eucalyptra gigantea Sm. New species. G.
2843 Erastria carneola Gn. B.
2862 Xanthoptera nigrofimbria Gn. B.

2877 Tripudia opipara Hy. Edw. B.
Minofala instans Sm. New species. G.
2884 Metoponia obtusa H.-S. B. and G.
2910 Acontia nuicula Sm. B.
2913 aprica Hbn. B. and G.
2922 cretata G. and R. B.
2933 libedis Sm. B.
2935 candefacta Hbn. B. and G.
2937 Fruva fasciatella Grt. B.
2957 Metathorasa argentilinea Wlk. B.
2971 Parora texana Grt. var.? B.
2973 Homopyralis contracta Wlk. B.
2999 Cænurgia convalesceus Gn. G.
3005 Panula inconstans Gn. B.
3008 Melipotis nigrescens G. & R. B. and G.
3014 versabilis Harv. B.
3015 jucunda Hbn. B.
3020 Cirrhobolina mexicana Behr. B.
3150 Panapoda rufimargo Hbn. B.
3153*a* Remigia marcida Gn. G.
3168 Phurys vinculum Gn. B.
3171 lima Gn. G.
3186 Eubolina impartialis Harv. B.
3187 Campometra amella Gn. B.
3188 bilineata Sm. B.
3190 Heteranassa mima Harv. B.
3205 Yrias repentis Grt. B.
3217*b* Homoptera edusa Dru. B.
strigimacula Du. B.
3274 Tetanolita mynesalis Wlk. B.
3294 Salia interpuncta Grt. B.
Rhescipha snowi Skinner. New species. B.

Family NOTODONTIDÆ.

3364 Datana floridana Graef. G.
3404 Heterocampa bilineata Pack. G.
3424 Harpyia cinerea Wlk. B.
Gonodonta pyrgo Cramer. B.

Family LASIOCAMPIDÆ.

3462 Artace punctistriga Wlk. B.

Family GEOMETRIDÆ.

3743 Hæmatopsis grataria Fabr. G.
3838 Chlorochlamys chloroleucaria Gn. B.
3857 Synchlora denticulata Wlk. B.
3878 Fernaldella fimetaria G. & R. B. and G.
3879 stalachtaria Strck. B.
4102 Tornos scolopacinarius Gn. B.

Family PYROMORPHIDÆ.

Harrisina mexicana Schaus. B.

Family PRYALIDÆ.

4638 Hymenia perspectalis Hbn. G.
4660 Conchylodes platinalis Gn. B. and G.
4687 Diaphania hyalinata Linn. B.
4688 quadristigmalis Grt. G.
4817 Pyrausta phœnicealis Hbn. B.
4826 laticlavia G. & R. G.
4846 Eustixia octonalis Zell. B. and G.
4849 Noctuelia thalialis Wlk. B.
4919 Schœnobius forficellus Thunb. B.
4994 Argyria argentana Martyn. G.

SUMMARY OF FAMILIES AND SPECIES OF LEPIDOPTERA.

Nymphalidæ	14	Lithosiidæ	1
Libytheidæ	1	Arctiidæ	7
Erycinidæ	2	Agaristidæ	1
Lycænidæ	4	Noctuidæ	56
Papilionidæ	11	Notodontidæ	4
Hesperidæ	12	Lasiocampidæ	1
Sphingidæ	3	Geometridæ	6
Ceratocampidæ	1	Pyromorphidæ	1
Syntomidæ	2	Pyralidæ	10

Totals: Families, 18; species, 137.

II.—LIST OF COLEOPTERA.

The author gratefully acknowledges his indebtedness to Mr. Charles Liebeck, Mr. H. C. Fall and Mr. C. Schaeffer for the determination of species not readily identified from the University of Kansas collection.

The numbers are those of Henshaw's lists.

Abbreviations: B. for Brownsville; G. for Galveston.

Family CICINDELIDÆ.

12 Tetracha carolina Linn. B.
38 Cicindela rectilatera Chd. B. and G.
39 tenuisignata Lec. B.
41 tortuosa Dej. B. and G.
42*b* saulcyi Guer. G.
43 hamata Brulle. B. and G.
inquisitor Casey. B.
59 togata Laf. G.
60 pamphila Lec. B. and G.
61 severa Laf. G.

Family CARABIDÆ.

70 Omophron labiatum Fab. G.
127 Calosoma scrutator Fab. B.
129 frigidum Kirby. G.

130 Calosoma sayi Dej. G.
220 Scarites subterraneus Fab. G.
Dyschirius duplicatus? Fall. G.
273 Clivina ferrea Lec. B.
275 bipustulata Fab. B.
295 Panagæus crucigerus Say. G.
311 Bembidium coxendix Say. B.
367 nubiculosum Chd. B.
391 versicolor Lec. B.
394 constrictum Lec. G.
421 lævigatum Say. B.
448 Tachys occultator Casey. G.
479 Pogonus texanus Chd. G.
481 lecontei Horn. B.
563 Pterostichus texanus Lec. B. and G.
564 sayi Brulle. G.
Loxandrus, undet. species. G.
710 Diplochila laticollis Lec. G.
773 Platynus decorus Say. G.
789 collaris Say. G.
805 nutans Say. G.
847 Casnonia pennsylvanica Linn. B.
853 Galerita bicolor Dru. G.
855 Zuphium americanum Dej. B.
860 Thalpius hornii Chd. B.
882 Lebia viridis Say. B.
889 ornata Say. B.
892 analis Dej. B.
897 furcata Lec. B.
913 Blechrus pusio Lec. B.
Euproctus texanus Wickham. B.
917 Tecnophilus croceicollis Men. G.
922 Callida decora Fab. B.
Micragra brunnea Putzeys. B.
960 Helluomorpha texana Lec. B.
961 ferruginea Lec. B.
980 Brachynus puberulus Chd. G.
medius. B.
999 Chlænius orbus Horn. B.
1012 vafer Lec. G.
1022 texanus Horn. B.
1023 perplexus Dej. G.
1059 Agonoderus lineola Fab. G.
1060 infuscatus Dej. G.
1061 pallipes Fab. G.
1064 indistinctus Dej. G.
1066 micros Lec. G.
1083 Harpalus caliginosus Fab. G.
1087 pennsylvanicus De G. G.
1124 Selenophorus palliatus Fab. B. and G.

1126 Selenophorus fatuus Lec. B.
1136 Stenolophus spretus Dej. G.
1146 dissimilis Dej. B.
1176 Anisodactylus piceus Men. G.
1180 rusticus Say. G.
gravidus Lec. G.

Family HALIPLIDÆ.

1226 Haliplus ruficollis De G. B.
Haliplus, new species. B.

Family DYTISCIDÆ.

1240 Hydrocanthus iricolor Say. B.
1249 Laccophilus americanus Aube. B.
1250 terminalis Sharp. B.
1252 4-lineatus Horn. B.
1294 Cœlambus medialis Lec. G.
1401 Copelatus chevrolatii Aube. B. and G.
1480 Hydaticus bimarginatus Say. G.
1495 Thermonectes ornaticollis Aube. B.
1496 basilaris Harr. B. and G.
1496b latecinctus Lec. G.
1502 Cybister fimbriolatus Say. B. and G.

Family GYRINIDÆ.

1531 Gyrinus parcus Say. B.
1538 Dineutes emarginatus Say. B.

Family HYDROPHILIDÆ.

1561 Hydrochus variolatus Lec. B.
1587 Hydrophilus insularis Lap. B. and G.
1588 Tropisternus limbalis Lec. B.
1589 dorsalis Br. G.
1595 striolatus Lec. G.
1597 Hydrocharis obtusatus Say. G.
1610 Berosus immaculatus Zimm. B.
1613 infuscatus Lec. B.
1614 striatus Say. G.
1626 Philhydrus nebulosus Say. B.
1657 Creniphilus subcupreus Say. B.
1675 Cercyon prætextatum Say. G.

Family STAPHYLINIDÆ.

2182 Philonthus alumnus Er. B.
var. rufulus Fauvel. B.
2251 Actobius pæderoides Lec. B.
2462 Stenus arculus Er. B. and G.
2492 Cryptobium texanum Lec. G.
2533 Lathrobium seriatum Lec. G.
2543 dimidiatum Say. B.
2585 Pinophilus latipes Grav. G.
2707 Bledius fortis Lec. G.

2709 Bledius brevidens Lec. G.
2717 semiferrugineus Lec. G.
2722 rubiginosus Er. B.
Apocellus, undet. species near sphæricollis Say. B.
Staphylinid, undet. genus and species. B.

Family PHALACRIDÆ.

9877 Olibroporus punctatus Casey?. B.
9879 Acylomus calcaratus Casey. B.
9881 ergoti Casey?. B.
3005 Olibrus apicalis Melsh. B.
Phalacrid, undet. genus and species. B.

Family CORYLOPHIDÆ.

3031 Orthoperus suturalis Lec. B.

Family COCCINELLIDÆ.

3034 Anisosticta seriata Melsh. G.
3036 Megilla fuscilabris Muls. B.
3046 Hippodamia convergens Guer. B.
3064 Cycloneda sanguinea Linn. B.
3065 Olla oculata Fab. B.
3065*a* abdominalis Say. B.
Brachyacantha decora Casey. B.
3142 Scymnus cinctus Lec. B.
3148 collaris Melsh. G.

Family EROTYLIDÆ.

3200 Languria mozardi Lat. B.
3204 angustata Beauv. G.
3205 convexicollis Horn. B.
Dasydactylus cnici Schaeffer. B.

Family CUCUJIDÆ.

3306 Silvanus rectus Lec. B.
3311 Scalidia linearis Lec. B.
Loberus ornatus Schaeffer. B.
3339 Læmophlæus ferrugineus Steph. G.

Family MYCETOPHAGIDÆ.

3409 Typhœa fumata Linn. B.

Family DERMESTIDÆ.

Cryptorhopalum festivum Casey. B.
obesulum Casey. B.
3449 hæmorrhoidale Lec. B.

Family TROGOSITIDÆ.

3838 Tenebrioides corticalis Melsh. B.
3848 Peltis pippingskoeldi Mann. B.

Family PARNIDÆ.

Throscinus schwarzi Schaeffer. B.

Family HETEROCERIDÆ.

3964 Heterocerus mollinus Kies. G.
3965 collaris Wies.? B.
3968 pallidus Say. B. and G.
3969 pusillus Say. B.
10016 schwarzi Horn. G.

Family DASCYLLIDÆ.

4006 Scirtes orbiculatus Fab. B.

Family ELATERIDÆ.

4092 Alaus lusciosus Hope. G.
4135 Esthesopus præditus Horn. B.
4140 Aptopus peregrinus Horn. B.
4182 Monocrepidius aversus Lec. B.
4185 vespertinus Fab. B.
undet. species. G.
4197 Ischiodontus var. oblitus Cand. B.
4250 Drasterius grandicollis Horn. B.
4277 Ludius hepaticus Germ. B.
Glyphonyx, undet. species. B.
4512 Pyrophorus physoderus Germ. B.

Family BUPRESTIDÆ.

4657*a* Chrysobothris analis Lec. B.
10069 edwardsii Horn. B.
4699 Acmæodera pulchella Hbst. B.
4699 pulchella, var. B.
4730 Agrilus lecontei Saund. B.
4755 Taphrocerus gracilus Say. B.
4756 agriloides Cr. B.

Family LAMPYRIDÆ.

4821 Pyropyga minuta Lec. B.
4825 Pyractomena ecostata Lec. G.
4847 Photuris pennsylvanica De G. B.
4872 Chauliognathus scutellaris Lec. B.
4876 marginatus Fab. B.
4973 Lobetus abdominalis Lec. B.

Family MALACHIDÆ.

5007 Collops balteatus Lec. B. and G.
5013 vittatus Say. B.
undet. species. G.

Family CLERIDÆ.

5127 Elasmocerus terminatus Say. B.
californicus Fall. B.
5138 Cymatodera fascifera Lec. B.
5165 Clerus quadrisignatus Say. B.
5173 abruptus Lec. B.

5195 Hydnocera pubescens Lec. B.
Pelonium, new species. B.
maculicolle Schaeffer. B.
5225 Orthopleura var. punctatissimus Chevr. B.

Family PTINIDÆ.

5243 Ptinus bimaculatus Melsh. B.
Catorama ventrale Lec. B.
grande Fall. B.
Sinoxylon, undet. species, probably new. B.
5355 Amphicerus punctipennis Lec. B. and G.
5369 Polycaon obliquus Lec. B.

Family SCARABÆIDÆ.

5439 Canthon perplexus Lec. B.
5442 Chœridium lecontei Harold. B.
5452 Phanæus carnifex Linn. G.
5486 Atænius imbricatus Melsh. G.
5490 oblongus Horn. B.
5491 gracilis Melsh. B.
10185 inops Horn. B.
10190 cognatus Lec. B. and G.
5533 Aphodius lividus Oliv. B. and G.
5560 concavus Say. B.
undet. species. B.
5581 Ochodæus biarmatus Lec. B.
5584 sparsus Lec. B.
Bradycinetus minor Linell. B.
5589 serratus Lec. B.
5591 Bolboceras lazarus Fab. G.
5616 Trox suberosus Fab. B. and G.
5719 Diplotaxis truncatula Lec. B.
undet. species near punctata Lec. B.
5737 Lachnosterna cribrosa Lec. B.
5742 torta Lec. B.
5772 crassissima Blanch. G.
5793 submucida Lec. B.
5797 crinita Burm. B. and G.
10240 dubia Smith. B.
5800 Phytalus robustus Horn. B.
cavifrons Linell. B.
5813 Listrochelus obtusus Lec. B.
5830 Anomala flavipennis Burm. B. and G.
5831 binotata Gyll. B.
binotata, form luteipennis Lec. B.
polychalca Bates. B.
Strigoderma, undet. species. G.
5878 Cyclocephala immaculata Oliv. G.
5767 Chalepus obsoletus Lec. G.
5868 trachypygus Burm. B. and G.

5869 Ligyrus gibbosus De G. G.
5870 ruginasus Lec. B.
5872 rugiceps Lec. G.
5881 Strategus antæus Fab. G.
5883 julianus Burm. B. and G.

Family SPONDYLIDÆ.

5947 Parandra polita Say. B. and G.

Family CERAMBYCIDÆ.

5955 Mallodon serrulatus Lec. G.
5990 Hylotrupes bajulus Linn. G.
6024 Achryson surinamum Linn. B.
6045 Eburia ovicollis Lec. B.
6046 tumida Lec. B.
6047 mutica Lec. B.
6048 manca Lec. B.
Psyrassa texana Schaeffer. B.
6059 Elaphidion inerme Newm. B.
6064 pumilum Newm. G.
6067 Aneflus tenuis Lec. B.
6073 Elaphidion mœstum Lec. B.
Ibidion townsendii Linell. B.
6090 Phyton pallidum Say. B.
Obrium mazinnæ Linell. B.
6106 Ancylocera bicolor Oliv. B.
6119 Dendrobias quadrimaculatus Dup. G.
6163 Stenosphenus novatus Horn. B.
6169 Cyllene crinicornis Chev. B.
6180 Xylotrechus sagittatus Germ. G.
6389 Monohammus marmorator Kirby. G.
6425 Liopus wiltii Horn. B.
6426 crassulus Lec. B.
6433 Dectes spinosus Say. B.
6456 Ecyrus dasycerus Say. B.
6468 Oncideres texana Horn. B.
6471 Ataxia crypta Say. B. and G.
6473 Dorcasta cinerea Horn. B.
6490 Mecas inornata Say. G.
6492 pergrata Say. G.
Aporataxia lineata Hamilton. B.

Family CHRYSOMELIDÆ.

6579 Anomœa laticlavia Forst. G.
6580 mutabilis Lac. B.
6582 Euryscopa lecontei Cr. B.
6588 Coscinoptera canella Lec. B.
6596*a* Babia pulla Lec. B.
6601*b* Chlamys polycocca Lac. B.
6620 Cryptocephalus cribripennis Lec. B.
6622 leucomelas Suffr. B.

6641 Cryptocephalus fulguratus Lec. B.
new species. B.
6649 Griburius scutellaris Fab. B. and G.
6651 montezumæ Suffr. B.
6660 Pachybrachys abdominalis Say. B. and G.
undet. species. B.
Metachroma, undet. species. B.
6707 Diachus auratus Fab. B.
6732 Glyptoscelis crypticus Say. B.
prosopis Schaeffer. B.
6738 Myochrous denticollis Say. B.
magnus Schaeffer B.
10369 Colaspoides opacicollis Horn. B.
6747 Typophorus canellus Fab. B.
6769 Graphops marcassita Cr. G.
6774 Colaspis brunnea Fab. B.
6791 Doryphora dahlbomi Stal. B.
6800 disrupta Rog. B.
6810*a* bigsbyana Kirby. B.
6839 Lina scripta Fab. B.
6880 Diabrotica connexa Lec. B.
6881*a* tenella Lec. G.
6883 balteata Lec. B.
6885 vittata Fab. B.
6888 longicornis Say. B. and G.
peregrina Jacoby. B.
undet. species. B.
6911 Galeruca integra Lec. G.
6913 maritima Lec. G.
6928 Œdionychis gibbitarsis Say. B.
6929 lustrans Cr. B.
6930 8-maculata Cr. B.
Andrector ruficornis Oliv. B.
6931 Œdionychis interjectionis Cr. B. and G.
6938 petaurista Fab. B. and G.
6949 Disonycha 5-vittata Say. B.
6951 glabrata Fab. B.
6954 abbreviata Melsh. B.
6959 rufa Ill. B.
10416 crenicollis Say. B.
10418 varicornis Horn. B.
6960 Haltica bimarginata Say. B.
6963 ignita Ill. B.
6971 foliacea Lec. G.
undet. species. B.
10438 Longitarsus vanus Horn. G.
Epitrix, undet. species. B.
6980 Crepidodera helxines Linn. B.
two undet. species. B.
Plectroteta flexicaulis Schaeffer. B.

7000 Systena elongata Fab. B.
7087 Charistena bicolor Smith? or new species. B.
7104 Coptocycla guttata Oliv. B.
7107 clavata Fab. B.
7109 Chelymorpha var. 17-punctata Say. G.

Family BRUCHIDÆ.

7126 Bruchus ramicornis Boh. G.
7128 bivulneratus Horn. B.
7129 cruentatus Horn. G.
7131 discolor Horn. G.
7142 uniformis Lec. B.
7145 perforatus Horn. G.
7149 amicus Horn. B. and G.
texanus Schaeffer. B.

Family TENEBRIONIDÆ.

Eurymetopon?, undet. species. B.
7190 Emmenastus texanus Lec. B.
7201 Epitragus acutus Lec. B.
7391 Nyctobates pennsylvanica De G. B.
Eleodes, undet. species near extricata Say. B.
7416 Tenebrio obscurus Fab. G.
7426 Opatrinus aciculatus Lec. G.
Blapstinus, undet. species. G.
7434 fortis Lec. G.
10603 arenarius Casey. B.
Paratenetus, undet. species. G.
7567 Helops perforatus Horn. B.
Strongylium varians Champ. B.

Family CISTELIDÆ.

7589 Allecula punctulata Melsh. B.
Hymenorus, undet. species. B.
10638 Lystronichus piliferus Champ. B.
Lobopoda punctulata. B.

Family LAGRIIDÆ.

Statira simulans Schaeffer. B.

Family MELANDRYIDÆ.

Polypria crux-rufa Chev. B.

Family ŒDEMERIDÆ.

7733 Nacerdes melanura Linn. G.
7735 Xanthochroa trinotata Lec. G.
7739 Oxacis cana Lec. B.
7748 dorsalis Melsh. G.

Family MORDELLIDÆ.

Anaspis, undet. species. B.
7782 Mordella octopunctata Fab. G.
7783 marginata Melsh. B.

7793 Glipodes sericans Melsh. B.
7816 Mordellistena comata Lec. G.
7839 pustulata Melsh. B.
new species. G.

Family ANTHICIDÆ.

Stereopalpus impressicollis?. B.
7938 Anthicus tenuis Lec. B.
7946 vicinis Laf. B.
7960 punctulatus Lec. B.

Family MELOIDÆ.

8045 Gnathium texanum Horn. B.
8050 Zonitis longicornis Horn. B.
8079 Epicauta trichrus Pall. G.
8094 lemniscata Fab. B.
8111 Pyrota dubitabilis Horn. B.

Family OTIORHYNCHIDÆ.

8312 Tanymecus confertus Gyll. B.
Pandeletejus, undet. species. B.
8316 Compsus auricephalus Say. B and G.
Cyphus, undet. species. B.
Pseudocyphus flexicaulis Schaeffer. B.
8338 Coleocerus marmoratus Horn. B.
8340 Eudiagogus pulcher Fah. B. and G.

Family CURCULIONIDÆ.

8347 Sitones flavescens Marsh. B.
Apion, undet. species. B.
8549 Smicronyx corpulentus Lec. B.
Pachyphanes, undet. species. B.
8570 Endalus setosus Lec. B.
10975 Anthonomus leucostictus Dietz. B.
10985 grandis Boh. B.
Tychius, three undet. species. B.
Otidocephalus, undet. species. B.
8711 Læmosaccus plagiatus Fab. B.
8716 Conotrachelus seniculus Lec. B.
8725 similis Boh. B.
8741 Rhyssematus palmacollis Say. B.
8745 pruinosus Boh. B.
Chalcodermus serripes Fab. B.
8812 Copturus nanulus Lec. G.
8814 adspersus Lec. B.
Cœliodes tarsalis ——. G.
8829 tenuipes Lec. B.
8879 Baris ærea Boh. B.
undet. species. B.
Nicentrus, undet. species. G.
11142 Madarellus cuneatus Casey. B.

11191 Limnobaris ebena? Casey. B.
8952 Barilepton lineare Lec. B.
Barinids, two undet. genera and species. B.
Barinus albescens. B.

Family BRENTHIDÆ.

8966 Cylas formicarius Fab. B.

Family CALANDRIDÆ.

8978 Rhodobænus tredecimpunctatus Ill. G.
8984 Sphenophorus ochreus Lec. G.
8998 placidus Say. G.
9011 Calandra oryzæ Linn. B.
9032 Allomimus dubius Horn. B.

Family ANTHRIBIDÆ.

9218 Anthribus cornutus Say. B.
9227 Brachytarsus vestitus Lec. B. and G.
undet. species. G.

SUMMARY OF FAMILIES AND SPECIES OF COLEOPTERA.

Cicindelidæ	10	Malachidæ	3
Carabidæ	59	Cleridæ	9
Haliplidæ	2	Ptinidæ	6
Dytiscidæ	11	Scarabæidæ	41
Gyrinidæ	2	Spondylidæ	1
Hydrophilidæ	12	Cerambycidæ	31
Staphylinidæ	14	Chrysomelidæ	64
Phalacridæ	5	Bruchidæ	8
Corylophidæ	1	Tenebrionidæ	13
Coccinellidæ	9	Cistelidæ	4
Erotylidæ	4	Lagriidæ	1
Cucujidæ	4	Melandryidæ	1
Mycetophagidæ	1	Œdemeridæ	4
Dermestidæ	3	Mordellidæ	7
Trogositidæ	2	Anthicidæ	4
Parnidæ	1	Meloidæ	5
Heteroceridæ	5	Otiorhynchidæ	7
Dascyllidæ	1	Curculionidæ	30
Elateridæ	11	Brenthidæ	1
Buprestidæ	7	Calandridæ	5
Lampyridæ	6	Anthribidæ	3

Totals: Families, 42; species, 418.

III.—LIST OF HEMIPTERA-HETEROPTERA.

For invaluable aid in the determination of species the author is indebted to Messrs. E. P. Van Duzee and Otto Heidemann.

The numbers are those of Uhler's check-list.

Abbreviations: B. for Brownsville; G. for Galveston.

Family SCUTELLERIDÆ.

26 Homæmus proteus Stal. B.
26 proteus, var. B.

Family CORIMELÆNIDÆ.

59 Corimelæna pulicaria Germ. B. and G.
61 unicolor Pal. Beauv. G.

Family CYDNIDÆ.

79 Homaloporus pangæiformis Sign., probably. B.
103 Pangæus bilineatus Say. B.

Family PENTATOMIDÆ.

174 Podisus acutissimus Stal. B.
190 Brochymena quadripustulata Fab. B.
192 obscura H. Schf. B.
226 Œbalus pugnax Fab. B. and G.
237 Mormidea sordidula Stal. B.
247 Euschistus servus Say. G.
253 bifibulus Pal. Beauv. B.
256 comptus Walk. B. and G.
271 Proxys punctulatus Pal. Beauv. G.
300 Thyanta custator Fab. B.
324 Runibia proxima Dallas. B.
334 Nezara viridula Linn. G.
347 Banasa imbuta Walk. B.

Family COREIDÆ.

425 Chariesterus albiventris Burm. B.
cuspidatus Dist. B.
447 Mozena lunata Burm. B.
479 Acanthocephala declivis Say. B.
482 granulosus Dallas. B.
491 Leptoglossus phyllopus Linn. B. and G.
503 Pthia picta Drury. B.
518 Catorhintha texana Stal. B.
522 Anasa tristis De G. G.
524 andresii Guer. B.
560 Hyalymenus tarsatus Fab. B.
571 Stachyocnemus apicalis Dallas. B.
Cydamus borealis Dist. B.
573 Darmistus subvittatus Stal. B.
585 Harmostes serratus Fab. B.
586 near nebulosus Stal. B.
587 virescens Dallas. B.

[illegible] Corisus [illegible]alinus Fab. B.
[illegible] [illegible]alis Say. B.
[illegible] [illegible]ctigemmus Dallas. B.
[illegible] [illegible]ricornum Sign. B.
[illegible] new species.
[illegible] Jalera [illegible]maculata H. Schf. G.

Family [illegible]

[illegible] Nysius [illegible]ensis Stal. B.
[illegible] [illegible]ensis Uhl. B.
[illegible] Cymus [illegible]atus Stal. G.
[illegible] Ischnodemus, near [illegible] Dr G. G.
[illegible] Geocoris pallens Stal. B. and G.
[illegible] Ligyrocoris constrictus Say. G.
Perigenea, [illegible] species. B.
[illegible] Pamera longula Dallas. B. and G.
[illegible] [illegible]ticata Say. B.
[illegible] species. B.
[illegible] [illegible]alis Dallas. B.
[illegible] Pachimerus [illegible]ga Stal. B.
[illegible] Lygaeus [illegible]ia Dallas. B. and G.
[illegible] [illegible] H. Schf. B.
[illegible] Oncopeltus Dallas. B. and G.

Family Largidæ.

[illegible] Largus succinctus Linn. B. and G.
[illegible] Dysdercus minus Say. B.
[illegible] [illegible]ensis Stal. B.

Family Capsidæ.

[illegible] Trigonotylus [illegible] Reut. B. and G.
Creontiades signatus Dist.? B.
Pallacorris, near jurgionus Stal. B.
[illegible] Reathenia insignis Say. B.
[illegible] Omeromeropus nigriclavus Reut. B.
Hadrodema pulverulentum Uhl. B.
[illegible] Lygus distanti Atkinson. B.
[illegible] Phytocoris eximius Reut. B.
[illegible] Neurocolpus nubilus Say. B.
[illegible] Calocoris rapidus Say. B.
Megacoelum pusillum Uhl. B.
catullum Uhl. B.
[illegible] Lygus pratensis Linn. G.
[illegible] carolinæ Reut. B. and G.
[illegible] sallei Stal. B.
[illegible] Poeciloscytus basalis Reut. B.
Poecilocapsus, new species. B.
[illegible] Pycnoderes insignis Reut. G.
[illegible] Episcopus ornatus Reut. B.
[illegible] Atomoscelis seriatus Reut. B.
[illegible] Agalliastes suavis Reut. G.

Family ANTHOCORIDÆ.

1035 Triphleps insidiosus Say. G.

Family TINGITIDÆ.

1050 Piesma cinerea Say. B.
1056 Corythuca decens Stal. G.

Family PHYMATIDÆ.

1118 Phymata erosa Linn. G.

Family NABIDÆ.

1135 Phorticus collaris Stal. B.
1144 Coriscus ferus Linn. G.
undet. species near ferus L. B.

Family REDUVIIDÆ.

1152 Sinea diadema Fab. G.
1153 coronata Stal. B.
1168 Rocconata annulicornis Stal. B.
1172 Atrachelus cinereus Fab. B. and G.
1178 Repipta taurus Fab. B.
1209 Pindus socius Uhl. B.
Apiomerus spissipes Say. B. and G.
1231 Rasahus biguttatus Say. B.
1237 Melanolestes abdominalis H. Schf. B.
1247 Conorhinus rubro-fasciatus De G. B.
1267 Pnirontis infirma Stal. B.
1269 Pygolampis pectoralis Say. G.
1273 Oncocephalus geniculatus Stal.

Family EMESIDÆ.

1285 Emesa, near fratera Say. B.

Family GERRIDÆ.

1305 Limnotrecthus marginatus Say. B. and G.

Family VELIIDÆ.

Mesovelia mulsanti B. White. B.

Family SALDIDÆ.

1327 Salda signoretii Guer. G.
1331 sphacelata Uhl. B. and G.
1344 pallipes Fab. G.
vagator Uhl., MS. G.

Family BELOSTOMATIDÆ.

1380 Belostoma americanum Leidy. G.
1385 Benacus griseus Say. B. and G.

Family NEPIDÆ.

1396 Ranatra quadridentata Stal. B.

Family NOTONECTIDÆ.

1408 Buenoa platycnemis Fieb. B. and G.

Family CORIXIDÆ.

Corixa, five undet. species. B. and G.

SUMMARY OF FAMILIES AND SPECIES.

Scutelleridæ	2	Nabidæ	3
Corimelænidæ	2	Reduviidæ	13
Cydnidæ	2	Emesidæ	1
Pentatomidæ	13	Gerridæ	1
Coreidæ	23	Veliidæ	1
Lygæidæ	15	Saldidæ	4
Largidæ	3	Belostomatidæ	2
Capsidæ	21	Nepidæ	1
Anthocoridæ	1	Notonectidæ	1
Tingitidæ	2	Corixidæ	5
Phymatidæ	1		

Totals: Families, 21; species, 117.

SOME RESULTS OF THE UNIVERSITY OF KANSAS ENTOMOLOGICAL EXPEDITIONS TO ARIZONA in 1904 and 1905.

By F. H. SNOW, University of Kansas, Lawrence.

THE expedition of 1904 made its headquarters at Thomas's ranch, in Oak Creek canyon, twenty miles southwest of Flagstaff, in Coconino county, 6000 feet above sea-level, the locality visited in 1902. My associates were Prof. W. H. Johnson and two students, Messrs. Eugene Smyth and Judah Drisko. Our collecting continued for seven weeks, from July 16 to September 2.

The expedition of 1905 made camp on the San Bernardino ranch, in the valley of Sycamore creek, between the Perilla mountains and the Peloncillo mountains, eighteen miles east of Douglas, in Cochise county, in the southeast corner of Arizona, and close to the United States and Mexico boundary line. This ranch is an oasis in the desert, and its proprietor, Mr. J. H. Slaughter, and his estimable wife and family rendered us many valuable services. Our tents were pitched in close proximity to a flowing artesian well, about three quarters of a mile from the ranch houses and within a quarter of a mile of the spot where the Apache chieftain, Geronimo, gave up his arms. The altitude of our camp was about 3750 feet above sea-level. My assistants on this trip were three students, Messrs. Eugene Smyth, Ebb Crumb, and Rollin Perkins, and I have never had a more indefatigable corps of collectors. Our collecting period included five weeks, from July 30 to September 2, making a total of twelve weeks of field-work for the species enumerated in these lists.

I.—LIST OF LEPIDOPTERA.

For invaluable aid in the determination of species not readily determined from the University of Kansas collection, the author is indebted to Dr. Henry Skinner and Prof. John B. Smith.

The numbers and nomenclature are those of Smith's check-list of 1903.

Abbreviations: S. for San Bernardino ranch; O. for Oak Creek canyon.

Family NYMPHALIDÆ.

1 Danais plexippus Linn. S. and O.
2 berenice Cram. O.
2*a* strigosa Bates. S. and O.

Family CORIXIDÆ.

Corixa, five undet. species. B. and G.

SUMMARY OF FAMILIES AND SPECIES.

Scutelleridæ	2	Nabidæ	3
Corimelænidæ	2	Reduviidæ	13
Cydnidæ	2	Emesidæ	1
Pentatomidæ	13	Gerridæ	1
Coreidæ	23	Veliidæ	1
Lygæidæ	15	Saldidæ	4
Largidæ	3	Belostomatidæ	2
Capsidæ	21	Nepidæ	1
Anthocoridæ	1	Notonectidæ	1
Tingitidæ	2	Corixidæ	5
Phymatidæ	1		

Totals: Families, 21; species, 117.

15 Argynnis nitocris Edw. O.
20 nausicaa Edw. O.
103 Melitæa chara Edw. S.
127 Phyciodes camillus Edw. S. and O.
128 mylitta Edw. O.
131 picta Edw. S.
137*a* Synchloe crocale Edw. S.
157 Pyrameis huntera Fabr. O.
158 cardui Linn. S. and O.
169 Timetes petreus Cram. S.
175*a* Limenitis arizonensis Edw. O.
177 wiedemeyerii Edw. O.
180 obsoleta Edw. S.
182*a* Heterochroa californica Butl. O.
200 Neonympha henshawi Edw. O.
205 rubricata Edw. O.
228*e* Satyrus olympus Edw. O.
231 meadii Edw. O.
251 Chionobas œno Bdv. S.

Family LIBYTHEIDÆ.

255*a* Libythea bachmani Kirtl. S.

Family ERYCINIDÆ.

260 Lemonias nais Edw. O.
261 palmerii Edw. S.
264 Calephelis borealis G. & R. S.

Family LYCÆNIDÆ.

271 Thecla crysalus Edw. O.
285 californica Edw. O.
311 leda Edw. S.
323 apama Edw. O.
325 læta Edw. O.
356 Lycæna phileros Bdv. O.
360*b* mertila Edw. O.
383*f* arizonensis Edw. O.
383*g* neglecta Edw. O.
384*a* herrii Grinnell. O.
385 comyntas Godt. O.
387 isola Reak. S.
390 hanno Stoll. O.
393 exilis Bdv. O.
394 marina Reak. O.

Family PAPILIONIDÆ.

398*a* Neophasia suffusa Stretch. O.
407 Pieris protodice Bd. & Lec. S.
411*a* Nathalis irene Fitch. S. and O.
423 Catopsilia eubule Linn. S.
433 Colias cæsonia Stoll. S.
438 eurytheme Bdv. S. and O.

454 Terias nicippe Cram. S. and O.
469 Papilio philenor Linn. S.
479 polyxenes Fabr. S.

Family HESPERIDÆ.

495*a* Copæodes procris Edw. O.
506 Pamphila taxiles Edw. O.
535 phylæus Dru. S. and O.
551 vestris Bdv. O.
559 lunus Edw. O.
565 ethlius Cram. S.
592 fusca G. & R. O.
600 Amblyscirtes nysa Edw. S.
604 ænus Edw. O.
607 nanno Edw. O.
613 Pyrgus occidentalis Skinner. New species. S. and O.
627 Nisoniades ausonius Lint. O.
631 petronius Lint. O.
638 pacuvius Lint. O.
641 funeralis Scud. & Burg. O.
649 Pholisora catullus Fabr. S.
651 pirus Edw. O.
691 Erycides amyntas Fabr. S.

Family SPHINGIDÆ.

702 Hemaris thetis Bdv. O.
729 Deilephila lineata Fabr. S. and O.
737 Pholus achemon Dru. O.
754 Phlegethontius quinquemaculata Haw. O.
766 Sphinx chersis Hbn., form oreodaphne Hy. Edw. O.
788*a* Marumba occidentalis Hy. Edw. S.

Family SATURNIIDÆ.

814 Agapema galbina Clem. S.
821 Coloradia pandora Blake. S.

Family SYNTOMIDÆ.

Cosmosoma rubrigutta Skinner. New species. S.
859 Scepsis fulvicollis Hbn. S.
866 Ctenucha venosa Wlk. S.

Family LITHOSIIDÆ.

Ruscino arida Skinner. New species. S.

Family NOLIDÆ.

909 Rœselia fuscula Grt. O.

Family ARCTIIDÆ.

926 Eubaphe ostenta Hy. Edw. O.
950 Estigmene acræa Dru. O.
955 Hyphantria textor Harr. S.
984 Apantesis proxima Guer. S.
1005 Euchætias murina Stretch. S.

1020 Euverna elio Pack. O.
1034 Euschausia ingens Hy. Edw. O.
1038 Eupseudosoma involutum Sepp. S.

Family AGARISTIDÆ.

1066 Copidryas gloveri G. & R.

Family NOCTUIDÆ.

1243 Caradrina meralis Morr. O.
Cyathassa, new species. S.
1329 Hadena perpensa Grt. O.
1444 Pyrophila pyramidoides Linn. O.
1459 Pseudanarta flavidens Grt. O.
1478 Oncocnemis aurea Grt. S.
1553 Aleptina inca Dyar. S.
1562 Rhynchagrotis variata Grt. O.
1639a Peridroma saucia Hbn. O.
1647 Noctua smithii Snell. O.
1655 c-nigrum Linn. O.
1717 Feltia herilis Grt. O.
1867 Euxoa atropulverea Sm. O.
1888 insulsa Wlk. O.
1895 intrusa Sm. O.
1900 basalis Grt. O.
1922 redimicula Morr. O.
2003 Mamestra trifolii Rott. S.
Barathra antonito Barnes. O.
2194 Leucania farcta Grt. O.
2226 Tæniocampa perforata Grt. S.
2231 incincta Morr. O.
2251 planalis Grt. O.
2268 Tricholita inconspicua Grt. S.
2334 Cucullia speyeri Lint. S.
2474a Calymnia calami Harv. O.
2448 Trichocosmia inornata Grt. S.
2502 Heliocheilus paradoxus Grt. S.
2504 Heliothis armiger Hbn. S. and O.
2530 Schinia conchula Feld. S.
2558 lynx Gn. S.
2569 arcifera Gn. O.
2596 Lygranthœcia siren Strck. S. and O.
2641 Fenaria sevorsa Grt. O.
Grotella binda Barnes. S.
Antaplaga hachita Barnes. S.
2659 Bessula luxa Grt. S.
2661 Narthecophora pulverea Sm. S.
2667 Stibadium spumosum Grt. S.
gloriosum. S.
2672 Cirrhophanus dyari Ckll. S.
Stiria aliago Barnes. S.
2683 Basilodes chrysopis Grt. S.

2810 Autographa californica Speyer. S. and O.
2720 brassicæ Riley. S. and O.
2752 Plusia accurata Hy. Edw.? S.
Minofala instans Sm. New species. O.
2842 Erastria propera Grt. S.
2851 Azenia implora Grt. S.
2852 edentata Grt. S.
2871 Thalpochares fortunata Grt. S.
2886 Metoponia macula Sm. S.
2892 Tornacontia tripartita Sm. S.
2893 altera Sm. S.
2895 Therasea angustipennis Grt. S.
2905 Acontia expolita Grt. S.
2907 niveicollis Sm. S.
2908 gonella Strck. S.
2914 areli Strck. S.
2922 cretata G. & R. S.
2924 elegantula Harv. S.
2933 libedis Sm. S.
2937 Fruva fasciatella Grt. S.
2950 Spragueia funeralis Grt. S.
2953 tortricina Zell. S.
Cissusa, new species. S.
Homopyralis cinctus Sm. New species. O.
3003 Euclidia dyari Sm. S.
3008 Melipotis nigrescens G. & R. O.
3020 Cirrhobolina mexicana Behr. S.
3021 vulpina Hy. Edw. S.
3085 Catocala aholibah Strck. O.
3092 mariana Hy. Edw. O.
3122 subnata Grt. O.
3143 Toxocampa victoria Grt. O.
3192 Heteranassa minor Sm. S.
3198 Matigramma rubrosuffusa Grt. S.
3202 Yrias clientis Grt. S.
3260 Zanclognatha ochreipennis Grt. O.
Renia rigida Sm. New species. O.

Family LASIOCAMPIDÆ.

3467 Tolype brevicrista Dyar. S.

Family GEOMETRIDÆ.

3707 Emplocia inconstans Geyer. O.
3878 Fernaldella fimetaria G. & R. S.
3879 stalachtaria Strck. S.
3493*a* Sciagraphia trifasciata Pack. O.
3946 Philobia enotata Gn. O.
3986 Cymatophora bitactata Wlk. O.
4140 Cleora pampinaria Gn. O.
4275*a* Metanema simpliciaria Grt. O.

4290 Stenaspilates albidula Hulst. O.
4292 Azelina ancetaria Hbn. O.
4299 Caberodes confusaria Hbn. O.

Family PYROMORPHIDÆ.

4461 Triprocris constans Hy. Edw. O.
4462 smithsonianus Clem. S.

Family SESIIDÆ.

4507 Melittia gloriosa Hy. Edw. S.
4514 Alcothoe korites Druce. O.
4545 Sesia giliæ Hy. Edw. O.
4547 mimuli Hy. Edw. O.

Family PYRALIDÆ.

4709 Nomophila noctuella Schiff. S.
4716 Loxostege obliteralis Wlk. S.
4718 helvialis Wlk. S.
4721 similalis Gn. S.
4722 allectalis Grt. S.
4725 sticticalis Linn. S.
4726 commixtalis Wlk. S. and O.
4741 ophionalis Wlk. S.
4818 Pyrausta toralis Grt. S.
4849 Noctuelia thalialis Wlk. S.
4872 Elophila avernalis Grt. O.
Thaumatopsis fernaldella Kearfott. S.
5021 Cacozelia basiochrealis Grt. S.

Family TORTRICIDÆ.

5493 Eucosoma ridingsana Rob.

SUMMARY OF FAMILIES AND SPECIES OF LEPIDOPTERA.

Nymphalidæ	22	Nolidæ	1
Libytheidæ	1	Arctiidæ	8
Erycinidæ	3	Agaristidæ	1
Lycænidæ	15	Noctuidæ	80
Papilionidæ	9	Lasiocampidæ	1
Hesperidæ	18	Geometridæ	11
Sphingidæ	6	Pyromorphidæ	2
Saturniidæ	2	Sesiidæ	4
Syntomidæ	3	Pyralidæ	13
Lithosiidæ	1	Tortricidæ	1

Species still in the hands of Messrs. Smith and Kearfott for determination, 60.

Totals: Families, 20; species, 262.

II.—LIST OF COLEOPTERA.

For the identification of species not readily determinable from the University of Kansas collection, the author is under obligations to Mr. Chas. Liebeck, Mr. H. C. Fall, and Mr. C. Schaeffer.

The numbers are those of Henshaw's list.

Abbreviations: S. for San Bernardino ranch; O. for Oak Creek canyon.

Family CICINDELIDÆ.

12 Tetracha carolina Linn. S. and O.
16*a* Cicindela obsoleta Say. S.
16*a* var. santaclaræ Bates. S.
20 nigrocærulea Lec. S.
21 pulchra Say. S.
22 hornii Schaupr. S.
23 pimeriana Lec. S.
33*a* var. maricopa Leng. O.
39 tenuisignata Fab. S.
57 lemniscata Lec. S.
arizonensis Bates: S.
wickhami W. Horn. S.
63 hæmorrhagica Lec. S.
64*b* 16-punctata Kl. S.

Family CARABIDÆ.

Cychrus vandykei Roetschke. O.
119 Carabus tædatus Fab. O.
126 Calosoma protractum Lec. S.
132 prominens Lec. S.
133 peregrinator Guer. S.
136 triste Lec. S.
140 simplex Lec. O.
215*a* Pasimachus costifer Lec. S.
218 punctulatus Hald. S.
273 Clivina ferrea Lec. S.
279 bipustulata Fab. S.
294 Panagæus sallei Chd. S.
343 Bembidium transversale Dej. S. and O.
345 lugubre Lec. S. and O.
351 lucidum Lec. O.
356 mixtum Zimm. S.
366 cordatum Lec. S.
397 dejectum Casey. S.
413 cautum Lec. O.
subangustatum Hayw. O.
timidum Lec. S.
constricticolle Hayw. S.
415 bifasciatum Mots. (=mundum Lec.) O.

449 Tachys nanus Gyll. O.
563 Pterostichus texanus Lec. S.
564 sayi Brulle. S.
579 lustrans Lec. O.
666 Amara confusa Lec. S.
674 obesa Say. O.
713 Dicælus lævipennis Lec. S.
742 Calathus gregarius Say. O.
744 opaculus Lec. O.
751 dubius Lec. O.
756 Platynus dissectus Lec. O.
771 brunneomarginatus Mann. O.
771 var. bicoloratus Germ. S.
new species. O.
773 decorus Say. S.
774b texanus Lec. S.
815 placidus Say. S.
842 Lachnophorus elegantulus Mann. S.
847 Casnonia pennsylvanica Linn. S.
860 Thalpius hornii Chd. S.
861 dorsalis Brulle. S.
875 Lebia majuscula Chd. S.
876 atriceps Lec. S.
882 viridis Say. S. and O.
891 scapula Horn. S.
897 furcata Lec. O.
902 bivittata Fab. S.
histrionica Bates. S.
917 Tecnophilus croceicollis Men. S.
927 Philophuga amœna Lec. S.
931 Plochionus timidus Hald. S.
940 Cymindus cribricollis Dej. S.
941 planipennis Lec. O.
985 Brachynus tschernikhii Mann. O.
986 carinulatus Mots. O.
undet. species. O.
991 Chlænius ruficauda Chd. S.
997 chaudoiri Horn. S.
1006 cumatilis Lec. S.
1008 leucoscelis Chev. S. and O.
1010 obsoletus Lec. S. and O
1022 texanus Horn. S.
1054 Nothopus zabroides Lec. S.
1055 Polpochila capitata Chd. S.
1056 Cratacanthus dubius Beauv. S.
1059 Agonoderus lineola Fab. S.
1064 indistinctus Dej. S.
1068 Discoderus impotens Lec. S.
1070 robustus Horn. S.
1081 Harpalus amputatus Say. S.

1087 Harpalus pennsylvanicus De G. S. and O.
1099 ellipsis Lec. O.
1109 fraternus Lec. O.
1121 alienus Lec. O.
1124 Selenophorus palliatus Fab. S.
1125 pedicularius Dej. S.
1158 Bradycellus rupestris Say. S.
1199 Anisodactylus maculicornis Chd. S.
1214 Pseudomorpha angustata Horn. S.

Family HALIPLIDÆ.

1229 Cnemidotus simplex Lec. S.

Family DYTISCIDÆ.

1243 Laccophilus decipiens Lec. S.
1246 pictus Lap. S.
1251 mexicanus Aube. S.
1266 Bidessus cinctellus Lec. O.
1291 Cœlambus patruelis Lec. ? O.
1294 medialis Lec. S.
1413 Agabus lugens Lec. S.
1459 Rhantus binotatus Harr. O.
1461 atricolor Aube. S.
1476 Eretes sticticus Linn. S.
1495a Thermonectes nigrofasciatus Aube. S.
1503 Cybister ellipticus Lec. S.

Family GYRINIDÆ.

1515 Gyrinus plicifer Lec. O.
1533 Dineutes sublineatus Chev. S.

Family HYDROPHILIDÆ.

1586 Hydrophilus triangularis Say. S.
1589 Tropisternus dorsalis Brulle. S.
1591 glaber Hbst. S.
1594 ellipticus Lec. S.
1605 Berosus styliferus Horn. S.
1607 subsignatus Lec. S.
1626 Philhydrus nebulosus Say. S.
9316 Cymbiodyta fraterculus Sharp. O.
1657 Creniphilus subcupreus Say. S.

Family SILPHIDÆ.

1698 Necrophorus marginatus Fab. S. and O.
1700 guttata Mots. S. and O.
1705 Silpha truncata Say. S. and O.

Family PSELAPHIDÆ.

Tyrus corticinus.
1917 Bryaxis foveata Lec. S. and O.
undet. species. O.

Family STAPHYLINIDÆ.

Lomechusa caseyi Wasm. S.
2059 Aleochara nitida Grav. S.
Gyrophæna?, undet. species. O.
2119 Creophilus villosus Grav. S. and O.
2123 Staphylinus nigrellus Horn. O.
2127 luteipes Lec. S.
2150 Philonthus furvus Nord. O.
2164 semiruber Horn. O.
2250 Actobius gratus Lec. S.
2305 Stenus renifer Lec. O.
Cryptobium, undet. species. S.
2500 tumidum Lec. S.
2542 Lathrobium lituarium Lec. S.
2610 Tachinus agilis Horn. O.
2636 Tachyporus californicus Horn. O.
2650 Conosoma castaneum Horn. O.
2712 Bledius armatus Er. S.
Trogophlœus?, undet. species. S.
2796 Deleaster concolor Lec. G.
2890 Lispinus æquipunctatus Lec.? O.

Family PHALACRIDÆ.

9874 Phalacrus conjunctus Casey. O.
3002 Olibrus pallipes Say. O.
3005 apicalis Melsh. S. and O.

Family COCCINELLIDÆ.

3037 Paranæmia similis Casey. S.
3046 Hippodamia convergens Guer. S. and O.
3049 sinuata Muls. O.
3051 parenthesis Say. O.
3064 Cycloneda sanguinea Linn. O.
3065 Olla oculata Fab. S.
3065*a* abdominalis Say. S.
Adalia humeralis Say. O.
humeralis, var. O.
3070 Harmonia cyanoptera Muls. S.
Anatis lecontei Casey.
3082 Exochomus pilatii Muls. O.
3090 Pentilla misella Lec. O.
9900 Thalassa montezumæ Muls. S.
3094 Brachyacantha dentipes Fab. O.
3101 Hyperaspis fimbriolata Melsh. S. and O.
3105 undulata Say. S.
3117 4-oculata Mots. S.
8126 Hyperaspidius trimaculatus Linn. O.
3138 Scymnus americanus Muls. O.
3146 hæmorrhous Lec. S.
3173 Epilachna corrupta Muls. S. and O.

Family ENDOMYCHIDÆ.

3183 Aphorista morosa Lec. O.

Family EROTYLIDÆ.

3240 Erotylus boisduvali Chev. O.

Family CUCUJIDÆ.

3299 Silvanus surinamensis Linn. S.
3339 Læmophlæus ferrugineus Steph. S.

Family CRYPTOPHAGIDÆ.

3359 Antherophagus ochraceus Melsh. O.

Family MYCETOPHAGIDÆ.

3409 Typhœa fumata Linn. S.

Family DERMESTIDÆ.

3418 Dermestes marmoratus Say. S. and O.
3420 caninus Germ. S.
3423 carnivorus Fab. O.
3438 vulpinus Fab. S.
3445 Anthrenus varius Fab. O.
3455 Orphilus glabratus Fab. O.
var. subnitidus Lec.

Family HISTERIDÆ.

3460 Hololepta lucida Lec. S.
3496 incertus Mars. O.
3502 servus Er. S.
3511 pollutus Lec. S.
3516 vernus Say. S.
3539 Epierus nasutus Horn. O.
3577 Saprinus, near obscurus Lec. O.
3607 vitiosus Lec. S. and O.
3608 lubricus Lec. S.
3610 fimbriatus Lec. O.
new species. S.
Plegaderus, near difficilis. O.

Family NITIDULIDÆ.

3671 Carpophilus yuccæ Cr. S.
undet. species. O.
3721 Nitidula ziczac Say. S. and O.
3737 Meligethes mutatus Har. O.
Ips, new species. S.
3763 Pityophagus verticalis Horn. O.

Family LATRIDIIDÆ.

Latridius, sp. between cordicollis and liratus. O.
3810 Melanopthalma americana Mann. O.
distinguenda Com. S. and O

Family TROGOSITIDÆ.

3833 Trogosita virescens Fab. S. and O.
3837 Tenebrioides pleuralis Horn. O.
3838 corticalis Melsh. O.
3841 sinuata Lec. S.
3848 Peltis pippingskœldi Mann. O.

Family PARNIDÆ.

Parnus arizonensis Schaeffer. S.
3920 Dryops productus Lec. S. and O.

Family ELATERIDÆ.

4064 Anelastes drurii Kirby. O.
4077 Adelocera rorulenta Lec. O.
4086 Meristhus cristatus Horn. S.
4090 Chalcolepidius smaragdinus Lec. S.
10035 behrensi Cand. S. and O.
4092 Alaus lusciosus Hope. S. and O.
4095 melanops Lec. O.
10047 Cardiophorus dispar Blanch. S.
4101 edwardsii Horn. O.
4110 longior Lec. O.
4112 fulvipes Lec. O.
arizonicus Fall. New species. O.
4128 Horistonotus simplex Lec. S.
4181 Monocrepidius lividus De G. S.
4188 sordidus Lec. S.
4197 Ischiodontus soleatus Say. S.
4202 Elater rhodopus Lec. O.
4210 cordatus Horn. O.
4306 Melanotus macer Lec. S.
4322 fissilis Say. S.
4324 exuberans Lec. O.
4394 Athous nigripilis Mots. O.
4465 Corymbites rupestris Germ. O.
4482 hieroglyphicus Say. O.
4510 Asaphes memnonius Hbst. O.
Scaptolenus, new species. S.

Family BUPRESTIDÆ.

4561 Gyascutus obliteratus Lec. S.
4564 Hippomelas sphenicus Lec. S.
4565 cælatus Lec. S.
4568 Chalcophora angulicollis Lec. O.
4604 Buprestis nuttalli Kirby. O.
4605 læviventris Lec. O.
4610 lauta Lec. O.
4634 Anthaxia flavimana Gory. O.
4636 Chrysobothris octocola Lec. S.
4637 atabalipa Lap. S.
4639*a* alabamæ Gory. S. and O.

4639b Chrysobothris 4-impressa Lap. & Gory. O.
4639c lesueuri Lap. & Gory. O.
4641 cuprascens Lec. O.
4650 trinervia Kirby. O.
4653 debilis Lec. S.
4656 gemmata Lec. S.
near bicolor Horn. O.
new species. O.
10070 axillaris Horn. O.
10084 ærea Chev. O.
10094 Actenodes mendax Horn. S.
4675 Polycesta velasco Lap. & Gory. S.
velasco, var. or a new species O.
4677 Acmæodera amplicollis Lec. S. and O.
4679 amabilis Horn. O.
4686 miliaris Horn. O.
4687 sparsa Horn. S. and O.
4690 connexa Lec. S. and O.
4698 mima Gory. S.
4699 pulchella Hbst., var. O.
10101 bivulnera Horn. S.
4705 guttifera Lec. S.
10107 delumbis Horn. S.
disjuncta Fall. S.
falli Kerremans (=subcyanea Fall.) S.
conoidea Fall. O.
new species. O.
undet. species. S.
4743 Agrilus solitarius Gemm. O.
4746 egenus Gory. C.
10131 felix Horn. O.
new species. O.
4764 Pachyscelus purpureus Say.

Family LAMPYRIDÆ.

4767 Rhyncheros sanguinipennis Say. O.
4769 Lycus fernandezii Duges. S.
4800 Lygistopterus rubripennis Lec. O.
4811 Lucidota punctata Lec. O.
4815 Ellychnia corrusca Linn. O.
4817 Propyga fenestralis Melsh. S.
4845 Microphotus dilatatus Lec. S.
4865 Chauliognathus profundus Lec. S.
4872 scutellaris Lec. S.
4876 marginatus Fab. S.
Polemius regularis Fall. S.
undet. species. O.
4976 Malthodes bicolor Lec. O.

Family MALACHIDÆ.

5002 Collops bipunctatus Say. S. and O.
5004 4-maculatus Fab. O.
4-maculatus, var. O.
5010 laticollis Horn. O.
5012 punctulatus Lec. S.
new species. S.
5051 Attalus basalis Lec. O.
5055 moralus Lec. O.
new species. S.
three undet. species.
Pristoscelis, undet. species. O.
5109 Listrus senilis Lec. S. and O.

Family CLERIDÆ.

5127 Elasmocerus terminatus Say. S.
californicus Fall. S.
5134 Cymatodera cylindricollis Chev. S. and O.
5140 hopei Gray. O.
5151 ovipennis Lec. O.
arizonæ Wolcott. New species. S.
5155 Aulicus nero Spin. S.
5157 Trichodes illustris Horn. S.
5158 ornatus Say. O.
5164 Clerus spinolæ Lec. S.
5165 quadrisignatus Say. S.
5173 abruptus Lec. S.
5177 nigriventris Lec. O.
5179 mœstus Kl.
snowi Wolcott. New species. O.
5191 Hydnocera subfasciata Lec. O.
5197 discoidea Lec. S. and O.
new species. O.
5207 longa Lec. S.
5223 Enoplium humerale Horn. O.
5230 Necrobia rufipes Fab. S. and O.

Family PTINIDÆ.

Catorama gibbulum Fall. S.
inæquale Fall. S.
5340 Sinoxylon sericans Lec. S.
5343 sextuberculatum Lec. S.
5354 Amphicerus fortis Lec. S.
5377 Trogoxylon californicum Cr. S.

Family CIIDÆ.

Cis, three undet. species. O.

Family SCARABÆIDÆ.

5430 Canthon puncticollis Lec. S.
5432*a* corvinus Horn. S.
5433 cyanellus Lec. S.

5435 Canthon lævis Drury. S.
5437 indigaceus Lec. S.
5452 Phanæus carnifex Linn. S.
5457 Onthophagus coproides Horn. O.
10186 Atænius læviventris Horn. O.
5497 hirtus Horn. O.
5521 Aphodius crassulus Horn. O.
5529 vittatus Say. S.
5579 Ochodæus simplex Lec. S.
5582 frontalis Lec. S.
5583 striatus Lec. S.
5589 Bradycinetus serratus Lec. S.
5612 Trox scutellaris Say. S.
5617 punctatus Germ. S.
5618 tuberculatus De G. O.
5620 sonoræ Lec. O.
5648 Hoplia laticollis Lec. O.
5665 Dichelonycha truncata Lec. O.
5684 Serica mixta Lec. O.
5700 Diplotaxis puberula Lec. S.
undet. species near tristis Kirby. S.
undet. species near angularis Lec. S.
5718 dubia Lec.? S.
10262 Lachnosterna fucata Horn. S.
10264 ignava Horn. O.
5801 Phytalus cephalicus Horn. O.
5809 Listrochelus scoparius Lec. O.
5813 obtusus Lec.? O.
5820 Polyphylla hammondi, var. subvittata Lec. S.
5822 decemlineata Say. O.
5832 Anomala centralis Lec. S.
5846 Pelidnota lugubris Lec. S.
5848 Plusiotis lecontei Horn. O.
5865 Cyclocephala dimidiata Burm. S. and O.
5866 manca Lec. O.
5867 Chalepus obsoletus Lec. S.
5869 Ligyrus gibbosus De G. S.
10276 Aphonides dunniana Rivers. S.
5878 Orizabus snowi Horn. O.
5879 ligyroides Horn. O.
5880 Xyloryctes satyrus Fab. O.
5891 Phileurus illatus Lec. S.
5893 Allorhina mutabilis Gory. S.
Gymnetis impius Fall. S.
5903 Euphoria devulsa Horn. S.
5908 fascifera Lec. S.
5911 inda Linn. O.
5913 Cremastochilus planatus Lec. S.
5914 saucius Lec. S.

Family SPONDYLIDÆ.

5946 Parandra brunnea Fab. O.

Family CERAMBYCIDÆ.

5960 Ergates spiculatus Lec. O.
Derobrachus ferreri Casey. S.
5961 Prionus californicus Mots. O.
5964 palpalis Say. O.
5973 Nothorhina aspera Lec. O.
5974 Criocephalus productus Lec. O.
5976 asperatus Lec. O.
5990 Hylotrupes bajulus Linn. O.
6055 Elaphidion alienum Lec. S.
6067 Aneflus tenuis Lec. S.
6076 protensus Lec. S.
6105 Rhopalophora longipes Say. S. and O.
6115 Callichroma plicatum Lec. S.
6122 Stenaspis solitaria Say. S.
6126 Tragidion annulatum Lec. O.
6127*a* fulvipenne Say. O.
6147 Tylosis maculata Lec. S.
6153 Crossidius pulchellus Lec. S.
10298 longipennis Casey. S.
6158 Sphænothecus suturalis Lec. S.
6164 Stenosphenus lepidus Horn. S.
6166 debilis Horn. O.
new species. O.
6168 Cyllene antennatus White. S.
6172 decorus Oliv. O.
6180 Xylotrechus sagittatus Germ. O.
6332*b* Leptura cribripennis Lec. O.
10319 Ophistomis ventralis Horn. O.
6370 Monilema appressum Lec. S. and O.
6410 Cœnopœus palmeri Lec. S.
Liopus, undet. species. O.
6433 Dectes spinosus Say. S.
Hyperplatys, undet. species. O.
6447 Acanthocinus spectabilis Lec. O.
6455 Pogonocherus volitans Lec.? O.
6468 Oncideres texana Horn. S.
tessellatus Thoms. S.
6490 Mecas inornata Say. O.
6513*c* Tetraopes oregonensis Lec. O.

Family CHRYSOMELIDÆ.

10331 Aulacoscelis purpurea Horn. O.
6573 Lema trilineata Oliv. S.
6574 nigrovittata Guer. S.
undet. species. O.
undet. species near collaris Say. O.
6580 Anomœa mutabilis Lac. S.

6582 Euryscopa lecontei Cr. S.
parvula Jac. S.
6588 Coscinoptera canella Lec. S.
6589 mucorea Lec. S.
6593 Megalostomis pyropyga Lac. S.
6596*b* Babia tetraspilota Lec. S. and O.
6597 Saxinis apicalis Lec. S.
6598 omogera Lac. O.
6599 saucia Lec. O.
10346 sonorensis Jac. O.
6600 Urodera crucifera Lac. O.
6614 Cryptocephalus 4-maculatus Say. O.
6622 leucomelas Suffr. O.
6627 spurcus Lec. S.
new species. O.
6665 Pachybrachys viduatus Fab. S.
undet. species near atomarius Melsh. O.
convexus Jac.? O.
two new species. O.
two new species. S.
6707 Diachus auratus Fab. O.
6721 Xanthonia villosula Melsh. O.
6740 Myochrous squamosus Lec. S.
6741 Chrysochus auratus Fab. O.
6747*b* Paria 4-notata Say S.
Metachroma, undet. species near californicum Cr. S.
6767 Graphops pubescens Melsh. S. and O.
Nodonota, undet. species. S.
6772 Chrysodina globosa Say O.
6774 Colaspis brunnea Fab. var. S.
10366 intermedia Jac. S.
championi Jac. S.
6787 Doryphora lineolata Stal. S.
6789 10-lineata Say. S.
6792 haldemani Rog. S.
10373 peninsularis Horn. S.
6795 Chrysomela exclamationis Fab. S.
6796 conjuncta Rog . O.
6800 var heterothecæ Linell. O.
6813 tortuosa Rog S.
6815 serpentina Rog. S.
6821*a* cribraria Rog. O.
6836 Lina arizonæ Cr. S.
10382 Phyllecthrus subsulcatus Horn. S.
6881*a* Diabrotica tenella Lec. S. and O.
6883 balteata Lec. S.
6885 vittata Fab. S.
6887 virgifera Lec. S.
10401 Halticidea placida Horn. O.
6904 Galeruca tuberculata Say. O.
6911 integra Lec. O.

6916 Monoxia guttulata Lec. S.
6918 sordida Lec. S.
6933 Œdionychis lugens Lec. O.
6949 Disonycha 5-vittata Say. O.
6953 arizonæ Casey. S.
10419 politula Horn. S.
6960 Haltica bimarginata Say. O.
6962 carinata Germ. S. and O.
6971 foliacea Lec. S.
6980 Crepidodera helxines Linn. S.
6991 parvula Fab. O.
7002 Systena marginalis Ill. S.
7003 tæniata Say, var. blanda Melsh. S.
7010 Longitarsus livens Lec.? S.
7027 Phyllotreta albionica Lec. S.
7028 lewisii Cr. O.
7058 Psylliodes punctulata Melsh. S.
7064 Microrhopala vulnerata Horn. O.
7068 cyanea Say. O.
7073 Odontota collaris Say. O.
7087 Charistena bicolor Smith. S.
7098 Cassida bivittata Say. S.
Coptocycla, near aurichalcea Fab. O.
7103 arizonæ Cr. S.
7106 lecontei Cr. S.
7107 clavata Fab. S.
7109 Chelymorpha argus Licht. S.

Family BRUCHIDÆ.

7129 Bruchus cruentatus Horn. S.
7133 pruininus Horn. S.
7137 prosopis Lec. S.
7156 placidus Horn. O.
10474 julianus Horn.
new species. S.

Family TENEBRIONIDÆ.

7177 Trimytis pruinosa Lec. S.
7183 Eurymetopon emarginatum Casey. S.
10485 cylindricum Casey. S.
7196 Emmenastus acutus Horn. O.
7200 Epitragus submetallicus Lec. S.
7203 canaliculatus Say. S.
7203 pruinosus Horn. S.
10507 fusiformis Casey. S.
7221 Zopherus gracilis Horn. O.
7251 Ologlyptus anastomosis Say. S.
7261 Asida morbillosa Lec. S.
7283 convexicollis Lec. S.
7284*a* rimata Lec. S.
7286 elata Lec. S.
blapsoides Sol. O.

7307 Eusattus reticulatus Say. S.
7322 Eleodes carbonaria Say. O.
7324 quadricollis Esch. O.
7325 humeralis Lec. O.
7331 longicollis Lec. O.
7335 gracilis Lec. S.
7339 nigrina Lec. O.
7350 lecontei Horn. O.
7351 consobrina Lec. O.
7353 planipennis Lec. O.
10547 rileyi Casey. O.
10550 porcatus Casey. O.
7365 Embaphion contusum Lec. O.
7379 Argoporis costipennis Lec. O.
10568 alutacea Casey. S.
7392 Nyctobates subnitens Horn. S.
7394 Iphthimus serratus Mann. O.
7394*a* sublævis Bland. O.
Alæphus gracilis Fall. New species. O.
7422 Adelina lecontei Horn. S.
10577 Mecysmus parvulus Casey. S.
7432 Blapstinus auripilis Horn. S.
7433 dilatatus Lec. S.
7437 lecontei Muls. S.
7452 Notibius gagates Horn. S.
10617 Tribolium confusum Duv. S.
7489 Anædus rotundicollis Lec. S.
7520 Platydema americanum Lap. O.
7530 Hypophlœus substriatus Lec. O.
7568 Helops arizonensis Horn. S.
new species. S.

Family CISTELIDÆ.

10638 Lystronichus piliferus Champ. S.
10647 Hymenorus grandicollis Champ. S.
10653 prolixus Casey. O.
10659 ruficollis Champ. S.
near occidentalis Champ.
10678 Telesicles cordatus Champ. S.

Family LAGRIIDÆ.

10702 Statira pluripunctata Horn. S.

Family MONOMMIDÆ.

7645 Hyporhagus gilensis Horn. S.

Family MELANDRYIDÆ.

10709 Eustrophus repandus Horn. O.

Family ŒDEMENIDÆ.

7730 Ditylus obscurus Lec. S.
7746 Oxacis bicolor Lec. S.
7747 fuliginosa Lec. S.
lucana Lec. S.
subfusca Horn. S.

Family MORDELLIDÆ.

7760 Diclidia lætula Lec., var. O.
7761 Pentaria trifasciata Melsh. O.
7771 Anaspis pusio Lec. O.
7780 Mordella scutellaris Fab. S. and O.
Glipodes, undet. species. O.
Mordellistena, undet. species near adspersa Melsh. O.
probably new species. S.

Family ANTHICIDÆ.

Macratria brunnea Casey. S.
7919 Notoxus bifasciatus Lec. S. and O.
curvitrichus Casey.
7943 Anthicus californicus Laf. S.
7945 floralis Linn. S.
7965 obscurellus Lec. S.
7975 corcinus Lec. S.

Family MELOIDÆ.

8025 Nemognatha apicalis Lec. O.
8027 bicolor Lec. S.
8033 nigripennis Lec. O.
new species near immaculata Say. S.
8037 immaculata Say. S.
8042 Gnathium francilloni Kirby. O.
8047 Zonitis atripennis Say. S.
8049 bilineata Say. S.
three new species. S.
8056 Macrobasis longicollis Lec. S.
8067 tenella Lec. S.
8069 segmentata Say. S.
undet. species. O.
8074 Pleuropompha costata Lec. S.
8082 Epicauta ferruginea Say. S.
8085 callosa Lec. S.
8091 pardalis Lec. S.
8092 maculata Say. S.
8098 cupreola Duges. S.
8103 corvina Lec. S.
alastor Skinner. S.
abadona Skinner. S.
new species. S.
8107 Pyrota mylabrina Chev. S.
8110 postica Lec. S.
8130 Cantharis deserticola Horn. S.
8138 puberula Lec. O.
8139 biguttata Lec. S.

Family RHIPIPHORIDÆ.

8172 Toposcopus wrightii Lec. O.
8174 Rhipiphorus dimidiatus Fab. O.
8177 pectinatus Fall. S.

Family OTIORHYNCHIDÆ.

8249 Eupagoderes sordidus Lec. S.
8258 Anametis grisea Horn. O.
8267 Peritaxia hispida Horn. S.
8299 Aragnomus griseus Horn. O.
Pandeletejus, undet. species. O.
8317 Cyphus lautus Lec. S. and O.
lautus var. S.
8338 Coleocerus marmoratus Horn. S.

Family CURCULIONIDÆ.

8379 Apion melanarium Gerst. S. and O.
occidentale. S.
10860 Dinocleus denticollis Casey. O.
8515 Cleonaspis pulvereus Lec. S.
Cleonus, undet. species. S.
8546 Desmoris constrictus Say. S. and O.
8558 Smicronyx fulvus Lec. O.
undet. species. O.
8571 Endalus limatulus Gyll. S.
8603 Otidocephalus vittatus Horn. S.
8606 scrobicollis Boh. O.
8672 Orchestes puberulus Boh. O.
Tychius, undet. species near setosus Lec. O.
8711 Læmosaccus plagiatus Fab. O.
8716 Conotrachelus seniculus Lec. S.
8741 Rhyssematus palmacollis Say. S.
8742 lineaticollis Say. S.
8745 pruinosus Boh. S.
8812 Copturus nanulus Lec. S. and O.
8835 Cœliodes acephalus Say. O.
Pelenomus, undet. species. O.
8886 Pseudobaris farcta Lec. O.
Onychobaris, undet. species. O.
11160 Centrinus hospes Casey. S.
11178 Centrinites strigicollis Casey. O.

Family CALANDRIDÆ.

11214 Cactophagus subnitens Casey (according to Mr. Schæffer; gravidus Lec., says Mr. Fall). S.
8973 Scyphophorus acupunctatus Gyll.
8980 Sphenophorus simplex Lec. S.
three undet. species. S.
9026 Cossonus concinnatus Boh. O.
11237 Rhyncolus nimius Casey. O.

Family SCOLYTIDÆ.

9060 Pityophthorus materiarius Fitch.? O.
9064 pilosulus Lec.? O.
9146 Scolytus unispinosus Lec. O.
9162 Hylesinus imperialis Lec. O.

9179 Dendroctonus terebrans Oliv. O.
9190 Hylastes longus Lec. O.
9191 rufipennis Kirby. O.
undet. species. O.

SUMMARY OF FAMILIES AND SPECIES OF COLEOPTERA.

Cicindelidæ	14	Lampyridæ	13
Carabidæ	81	Malachidæ	14
Haliplidæ	1	Cleridæ	21
Dytiscidæ	12	Ptinidæ	6
Gyrinidæ	2	Ciidæ	3
Hydrophilidæ	9	Scarabæidæ	52
Silphidæ	3	Spondylidæ	1
Pselaphidæ	3	Cerambycididæ	39
Staphylinidæ	20	Chrysomelidæ	86
Phalacridæ	3	Bruchidæ	6
Coccinellidæ	22	Tenebrionidæ	46
Endomychidæ	1	Cistelidæ	6
Erotylidæ	1	Lagriidæ	1
Cucujidæ	2	Monommidæ	1
Cryptophagipæ	1	Melandryidæ	1
Mycetophagidæ	1	Œdemeridæ	5
Dermestidæ	7	Mordellidæ	1
Histeridæ	12	Anthicidæ	7
Nitidulidæ	6	Meloidæ	30
Latridiidæ	3	Rhipiphoridæ	3
Trogositidæ	5	Otiorhynchidæ	8
Parnidæ	2	Curculionidæ	25
Elateridæ	26	Calandridæ	8
Buprestidæ	44	Scolytidæ	8

Species in the hands of Mr. C. Schaeffer for determination, 46.
Totals: Families, 48; species, 724.

III.—LIST OF HEMIPTERA-HETEROPTERA.

This list includes all Arizona species collected by the University of Kansas entomological expeditions of 1902, 1903, 1904, and 1905.

The author is indebted to Messrs. E. P. Van Duzee and Otto Heidemann for the determination of species not readily identified from the University collections.

The numbers are those of Uhler's check-list.

Abbreviations: S. for San Bernardino ranch, eighteen miles east of Douglas, in Cochise county, altitude 3750 feet; O. for Oak Creek canyon, eighteen miles southwest of Flagstaff, altitude 6000 feet; B. for Bill Williams fork of the Colorado river, on the boundary line between Mohave and Yuma counties, altitude 1000 feet;

H. for Humphrey's Peak, fifteen miles north of Flagstaff, altitude 9500 feet; M. for Martinez, or Congress Junction, in Yavapai county.

Family SCUTELLERIDÆ.

25 Homæmus æneifrons Say. S.
26 proteus Stal. S.
bijugis Uhl. S.

Family CORIMELÆNIDÆ.

54 Corimelæna cærulescens Stal. S.
58 extensa Uhl. O.
64 nigra Dallas. S.
renormata Uhl. S.

Family CYDNIDÆ.

75 Cyrtomenus mirabilis Perty. O. and S.
Geotomus parvulus Sign. S.

Family PENTATOMIDÆ.

145 Perillus bioculatus Fab. S.
bioculatus, var. claudus Say. O.
148 Zicrona cuprea Dallas. S.
168 Podisus crocatus Uhl. S.
174 acutissimus Stal. S.
Liopus contaminatus Uhl. M.
Brochymena, undet. species near 4-pustulata Fab. S.
190 quadripustulata Fab. S.
192 obscura H. Schf. M. and S.
Pelidnocoris, undet. species. S.
216 Mecidea longula Stal. S.
Cosmopepla uhleri Montel. O.
223 carnifex Fab. O. and H.
242 Mormidea tetra Walk. S.
247 Euschistus servus Say. S. and O.
255 spurculus Stal. S.
257 biformis Stal. S.
258 integer Stal. S.
277 Menecles insertus Say. O.
282 Pentatoma ligata Stal. S.
osborni Van D. S.
284 sayi Stal. S. and B.
faceta Say. S.
296 Peribalus limbolarius Stal. S.
298 abbreviatus Uhl. S. and O.
300 Thyanta custator Fab. S., B., and M.
303 rugulosa Say. S.
brevis Van D.
Chlorocoris, undet. species near complanatus Guer. S.
314 Murgantia histrionica Hahn. S. and O.
336 Nezara hilaris Say. O.
344 Banasa sordida Uhl. O.

Family COREIDÆ.

438 Corynocoris distinctus Dallas. S.
440 Pachylis gigas Burm. S.
446 Mozena lineolata H. Schf. S., M., and B.
461 Archimerus calcarator Fab. O.
482 Acanthocephala granulosa Dallas. S.
493 Leptoglossus zonatus Dallas. S.
two undet. species. S.
494 near stigma Hrbt. S.
500 Narnia femorata Stal.? S.
501 pallidicornis Stal. M.
507 Chelinidea vittigera Uhl. S. and B.
515 Catorhintha mendica Stal. S.
517 selector Stal. S. and B.
522 Anasa tristis De G. S.
564 Alydus eurinus Say. S. and O.
566 (Megalotomus) quinquespinosus Say. O.
569 pluto Uhl. S. and O.
571 Stachyocnemus apicalis Dallas. S.
579 Scolopocerus secundarius Uhl. S.
580 uhleri Dist. S.
587 Harmostes reflexulus Stal. S. and O.
587 form virescens Dallas. S.
588 fraterculus Say. S. and O.
594 Aufeius impressicollis Stal. S.
595 Corizus hyalinus Fab. B.
599 bohemani Sign. O.
601 lateralis Say. S.
606 Leptocoris trivittatus Say. O.

Family BERYTIDÆ.

582 Jalysus spinosus Say. S. and B.
583 Acantholæna annulata Uhl. B.

Family LYGÆIDÆ.

Nysius minutus Uhl. S., O., and H.
near angustatus Uhl. S.
618 californicus Stal. S., O., B., H., and H. at summit, alt. 12,800 ft.
639 Geocoris pallens Stal. O. and S.
undet. species. S.
Heræus eximius Dist.
649 Phlegyas annulicrus Stal. S.
678 Ozophora picturata Uhl. O.
Scolopostethus thomsoni Reut. O.
Ptochiomera, new species. O.
Rhyparochromus floralis Uhl. S.
713 Lygæus bicrucis Say. S. and O.
715 facetus Say. S.
716 circumlitus Stal. O.
743 bicolor H. Schf. O. and B.
746 trux Stal. S.

752 Lygæus reclivatus Say. S. and O.
753 turcicus Fab. M. and B.
melanopleurus Uhl. O.
melanopleurus, var. brachypterus. O.
759 Oncopeltus fasciatus Dallas. S. and B.

Family LARGIDÆ.

765 Largus cinctus H. Schf. O.
766 succinctus Linn. S., O., and B.
773 Arhaphe carolina H. Schf. O.
779 Dysdercus obliquus H. Schf. S.

Family CAPSIDÆ.

806 Clivinema villosa Reut. S.
834 Resthenia persignanda Dist. S.
undet. species. O.
Phytocoris, new species near ramosus. S.
856 Compsocerocoris annulicornis Reut. S.
860 Calocoris rapidus Say. O.
863 superbus Uhl. S.
Lygus, new species. S.
881 pratensis Linn. S. and O.
pratensis, var. S.
889 invitus Say. S.
902 Pœciloscytus basalis Reut. S. and B.
Lampethusa anatina Dist. S.
920 Camptobrochis nebulosus Uhl. O.
644 Pycnoderes insignis Reut. S.
Halticoma, new species. S.
valida Uhl., MS. O.
Coquillettia mimetica Osborn. S.
insignis Uhl. O.
Oncotylus guttulatus Uhl. S.
989 Macrocoleus coagulatus Uhl. S. and H.
Psallus, undet. species. O.
997 Plagiognathus obscurus Uhl. O.
998 Atomoscelis seriatus Reut., var. S.

Family ARADIDÆ.

1077 Aradus similis Say.? O.
1105 Brachyrhynchus emarginatus Say.? O.

Family PHYMATIDÆ.

1118 Phymata erosa Linn. S. and O.

Family NABIDÆ.

1133 Pagasa nitida Stal. B.
1114 Coriscus ferus Linn. S. and O.
undet. species. S.

Family REDUVIIDÆ.

Sinea complexa Caudell. S. and B.
1152 diadema Fab. S., O., and B.
rileyi Montel. M.
1155 raptoria Stal. S.
1156 defecta Stal. O.
1159 Acholla multispinosa De G. O.
1172 Atrachelus cinereus Fab. S. and B.
1180 Castolus subinermis Stal. O.
1187 Milyas zebra Stal. O. and H.
1193 Zelus cervicalis Stal. S.
exsanguis Stal. B.
pictipes Dist. S.
1209 Pindus socius Uhl. S., M., and B.
1212 Apiomerus subpiceus Stal.? S.
1214 crassipes Fab. O.
spissipes Say. S.
Homalocorus minutus Mayr.? O. and H.
1232 Rasahus thoracicus Stal. S.
1237 Melanolestes abdominalis H. Schf. S.
1248 Conorhinus variegatus Drury. S.
1259 Opsicœtus personatus Linn. O.
1269 Pygolampis pectoralis Say. S.
Oncocephalus, new species. S.
1274 Narvesus carolinensis Stal. S.

Family LIMNOBATIDÆ.

1300 Hydrometra martini Kirkaldy. B.

Family GERRIDÆ.

1302 Gerris remigis Say. S., H., and O.

Family VELIIDÆ.

Velia brachialis Stal. O. and B.
Rhagovelia, undet. species. B. and H.

Family SALDIDÆ.

1337 Salda polita Uhl. B.

Family GELASTOCORIDÆ.

1356 Pelogonus americatus Uhl. B.
1357 Gelastocoris oculatus Fab. B., O., and H.

Family NAUCORIDÆ.

1362 Ambrysus signoretii Stal. S.
1365 melanopterus Stal. B.

Family BELOSTOMATIDÆ.

1372 Belostoma fusciventris Stal. S.
1373 anurus H. Schf. B. and O.

FAMILY NEPIDÆ.

1396 Ranatra quadridentata Stal.

Family NOTONECTIDÆ.

1398 Notonecta insulata Kirby. S.
1401 mexicana Am. & S. S.
indica Linn. S.

Family CORIXIDÆ.

Corixa, undet. species. B.
two undet. species. S.
Buenoa platycnemis Fieb. S.
Dendrocoris, apparently a new species. S.

SUMMARY OF FAMILIES AND SPECIES OF HEMIPTERA-HETEROPTERA.

Scutelleridæ	3	Reduviidæ	24
Corimelænidæ	4	Limnobatidæ	1
Cynidæ	2	Gerridæ	1
Pentatomidæ	32	Veliidæ	2
Coreidæ	29	Saldidæ	1
Berytidæ	2	Gelastocoridæ	2
Lygæidæ	21	Naucoridæ	2
Largidæ	4	Belostomatidæ	2
Capsidæ	24	Nepidæ	1
Aradidæ	2	Notonectidæ	3
Phymatidæ	1	Corixidæ	5
Nabidæ	3		

Totals: Families, 23; species, 171.

The author will publish at a later date lists of species belonging to the other orders of insects, together with additions to the foregoing lists from material not yet determined.

V.

BOTANICAL PAPERS.

"THE BOTANICAL FEATURES OF THE NEW UNITED STATES PHARMACOPŒIA."

By L. E. SAYRE, University of Kansas, Lawrence.

"A LITTLE EXPERIMENT IN FLOWER-MAKING."

By GRACE MEEKER, Ottawa.

"NOTES ON THE FLORA OF THE ROSEBUD INDIAN RESERVATION, SOUTH DAKOTA."

By ALBERT B. REAGAN.

THE BOTANICAL FEATURES OF THE NEW UNITED STATES PHARMACOPŒIA.

By L. E. SAYRE, University of Kansas, Lawrence.

THE eighth decennial revision of the United States Pharmacopœia, which has recently been published, is of interest to the chemist and botanist alike. In the pages of this legal standard there is contained a list of drugs derived from the vegetable kingdom. These drugs are from various parts of plants and the plants are distributed very widely over the globe. It is exceedingly interesting to the botanist to note that in the references made to botanical drugs an effort has been made in the recent revision, as far as possible, to restore the names given to the plants by the original authors. In some cases it has been almost impossible to make any such changes; for example, in our common wild cherry, which was made official in this standard work scores of years ago, and under the name of *Prunus virginiana*. It is well known that the botanical source of the medicinal wild cherry bark is from *Prunus serotina*. Therefore, the United States Pharmacopœia speaks of wild cherry as *Prunus virginiana* derived from the bark of *Prunus serotina*. Quite a number of changes have occurred in the new pharmacopœia resulting from the changes which investigation has made necessary in transferring plants into new families or natural orders. No less than twelve changes have been made by transferring plants into other orders than were formerly recognized as the proper order. In the case of Urticacæ, for example, in the pharmacopœia of 1890 the natural order Urticacæ included the following drugs: *Ulmus*, *Humulus*, *Cannabis indica*, *Ficus*. In the present pharmacopœia *Ulmus* is placed under the new order Ulmaceæ, and *Humulus* and *Cannabis indica* under the Moracacæ. Many of the plants and products of the pines that were formerly classified under the natural order Coniferæ are now classified under the family Pinaceæ. Examples of such changes as these, as I have said, are of interest to the botanist, and it goes to show that as old a science as botany claims to be, it is by no means incapable of change and improvement, when such changes as these are possible.

Under the description of drugs derived from the vegetable kingdom, the pharmacopœia shows strikingly the progress which has

been made in microscopical botany. Descriptions of crude drugs requiring the use of the compound microscope are found repeatedly in the text. Scattered here and there in the text of the pharmacopœia are found such statements as the following, quoting a paragraph under *Althæa* (marshmallow): "The powder contains rosette-shaped crystals of calcium oxalate, about 0.025 mm. in diameter, and ellipsoidal starch grains from 0.010 to 0.020 mm. in diameter."

The measurement of the official (corn) starch is stated as from about 0.010 to 0.025 mm. in diameter, but these are usually polygonal grains. In elm bark there are noted a few nearly spherical starch grains measuring from 0.005 to 0.010 mm. in diameter. We frequently hear the statement made that lycopodium consists of the pollen of *Lycopodium clavatum*. The pharmacopœia states that these microscopical elements are tetrahedral spores, from 0.025 to 0.040 mm. in diameter, and are multicellular; and that the microscope should reveal neither pollen nor starch grains.

In the case of *Sinapis* (both black and white mustard seed) and in flaxseed, the presence of starch, while admitted, is not revealed by the microscope. In these cases a "limit test" for starch is given, which, in the case of the mustards, reads as follows: "If 1 gm. of the powder be exhausted by slow percolation with alcohol and the mass mixed with 200 c.c. of water and heated to boiling, and if, after cooling, sufficient cold water be added to make the mixture measure 1000 c.c., the addition of 4 c.c. of tenth-normal iodine t. s. should not produce a dark blue color."

In the case of flaxseed, the limit test is substantially the same, but varies from the former, as will be seen: "If 1 gm. of ground linseed be mixed with 20 c.c. of water and the mixture heated to boiling, then cooled and diluted with cold water to 100 c.c., the addition of 0.5 c.c. of iodine t. s. should not produce more than a pale blue color."

It is important to note in this connection also that the compound microscope is called into requisition in the identification of anatomical structures, as, for example, in the description of the barks derived from *Viburnum opulus* and *Viburnum prunifolium*. Under *V. opulus* it is stated that transverse sections of the bark show several bands of bast fibers; while in the case of the *prunifolium* the statement is met that the cross-sections show groups of stone cells. These elements are satisfactorily distinguishable only by the aid of a one-inch (better by a one-fifth) objective, and seem to distinguish the two barks, even in form of powder.

In the new edition of the pharmacopœia it is evident that the committee of revision have endeavored to express in as few words as possible the most essential characteristics of the drug. The descriptions of these characteristics have been compressed into an average space of about ten lines. In the case of the description of aniseed, we have the following statement: "Ovoid, laterally compressed, 4 to 5 mm. long; carpels usually cohering and attached to a slender pedicel; grayish to greenish gray to grayish brown; each with a flat face and five light brown filiform ridges and about sixteen oil-tubes; odor and taste agreeable and aromatic. No mouse-like odor should be developed when solution of potassium hydroxide is poured upon anise (absence of conium). The powder contains one-celled, straight or curved, non-secreting hairs, which vary from 0.025 to 0.100 mm. in length."

Those who are familiar with these substances know how important it is to distinguish anise from conium, a poisonous fruit from the same family; a fruit which is readily mistaken for the innocent, aromatic aniseed. It would be impossible in this paper to give anything like a satisfactory analysis of the botanical work of the present pharmacopœia. The detailed description of the changes and improvements would require a small volume, but it is the object of this paper to call attention not only to the pharmacopœia itself, but to the botanical features of it which botanists should be interested in. Indeed, all scientists who are interested in the progress of a national work, a work that is recognized by various state laws and by the United States government, should be interested in the reviewing of this recently revised standard for medicinal substances, whether from the point of view of the sciences connected with the vegetable, animal or mineral kingdom.

A LITTLE EXPERIMENT IN FLOWER-MAKING.

By Grace Meeker, Ottawa.

THE little experiment in new flower-making which it is my pleasure to present to you was undertaken by Mrs. Orpha Kious Davis. In the spring of 1901, she sent to Winnipeg, Manitoba, for a chrysanthemum that bloomed early enough to escape the frosts of that northern climate. I cannot give the name of the variety which has this merit, but it is certainly a yellow-flowering one.

Having obtained the chrysanthemum, she planted with it plants of the common wild sunflower, in the hope of obtaining a cross between the two. Her method of effecting the exchange of pollen was simple—she brushed the faces of the flowers together in the morning "while the dew was on." The sunflowers fruited well, as is their wont, and the second season (1902) she planted seed from those plants again with the chrysanthemums. The flowers of the sunflower showed a few ligulate corollas in the disk and were misshaped and ugly. During this season she again brushed the faces together and saved the seed for planting.

In 1903 the results were much better; the flowers were quite double; that is, many of the tubular flowers of the disk were replaced by the ligulate corollas of the chrysanthemum, but the flowers were small.

During 1904 Doctor and Mrs. Davis were at the exposition in St. Louis, and nothing was done with the new flower. However, an incident occurred of sufficient value to record. A friend of Mrs. Davis from Bucyrus, Ohio, received three seeds of the flower which Doctor Davis happened to have in his pocket. After her return home, that is, this season, she planted the seeds and got excellent results. Unfortunately her letter telling of her success has been destroyed.

This season (1905) seeds were planted by Mrs. Davis in her flower-garden in Ottawa, and the results were wonderful.

The plant grows about five and one-half feet high—not nearly so tall as the sunflower. It branches near the ground; the branches well filled with flowers. The stalks are thick at the base—two inches a fair average. The leaves retain the sunflower shape, being only less coarse and stiff. The flowers this year were very perfect; the first ones large, some of them four inches across. The

involucre and row of rays of the sunflower are retained, even to the paler yellow of the rays. They are, however, longer and narrower. The disk has now become full of ligulate flowers of a bright golden yellow. While seed was formed this season, it was not so abundant as in former years.

It was Mrs. Davis's plan to experiment another year before she offered descriptions of her new flower, which she called a chrysanthemum-sunflower, for publication. The flowers attracted so much attention that one of the Ottawa papers printed an account; then she generously offered seed to all who cared to grow the flower.

In August Mrs. Davis died, and I am indebted to her husband, Dr. Geo. W. Davis, of Ottawa, for the facts here recorded. While not making any pretensions to scientific skill or attainments, Mrs. Davis was an ardent lover of nature, especially flowers, and had several experiments under way similar to this one.

The first flowers were grown at Princeton, Kan., and these most perfect ones at Ottawa.

NOTES ON THE FLORA OF THE ROSEBUD INDIAN RESERVATION, SOUTH DAKOTA.

By ALBERT B. REAGAN, Rosebud, S. Dak.

THE Rosebud Indian reservation is situated in South Dakota, south of Big White river, and extends from about the middle south line of the state east to the Rosebud lands opened for settlement in 1904. It is bounded on the north by Big White river, on the east by Gregory county (the land opened up for settlement), on the south by Nebraska, and on the west by the Pine Ridge Indian reservation. The soil is sandy Loup Fork Tertiary, Miocene clays or Cretaceous black shales as one proceeds northeast across the reservation from its southwest corner. In the eastern part of this area and in the valley regions the Minnesota and east Nebraska flora prevails; in the medium elevated regions, that of the high plains; and on the high points and in the western part of the reservation, that of the Rocky Mountains. Many Canadian species are also met with. The country in early spring to the middle of the summer is a rose-flower region; hence the name, Rosebud. The Leguminosæ are also prominent flowers, but, though more numerous in species than the Rosaceæ, are less conspicuous. In the summer the Leguminosæ and the Evening Primrose family vie with each other. The predominating flowers of the fall season are those of the Compositæ. The grass family is represented by numerous species, which are themselves very variable. The trees are usually low and spreading, and are usually found only along the streams.

The following list of identified plants are the result of the author's observations during the spring, summer and fall of 1904. The work was carried on as time would permit, and, consequently, contains only a small part of the plants of the region.

The books used in identifying the plants were Wood's "Eastern Botany," Bessey's "Botany for High Schools and Colleges," Gray's "Lessons and Manual of Botany," and Coulter's "Manual of Rocky Mountain Botany."

The date in parentheses is that on which the first bloom of that respective plant appeared.

Ranunculaceæ:

Anemone carolinana Walt.
Numerous.

Delphinium azureum Michx. Larkspur.
Common.

Caltha palustris Linn. Marsh marigold.
Common in low places.

Cruciferæ:
Brassica arvensis. Mustard.
Only one plant was seen, on the Butte Creek wagon-road, one mile east of the Widow Dire's place (specimen not native).
Lepidium intermedium Gray. Peppergrass.
Dry places, yards, roadsides, etc.
Camelinia sativa Crantz. False flax.
Common.

Violaceæ:
Viola cucullata Gray.
Common in valleys.
Viola sagittata Ait. Arrow-leaved violet.
Common in damp places (April 6).
Viola delphinifolia. Blue violet.
Common (May 16).
Viola rotundifolia Michx. Yellow violet.

Portulacaceæ:
Portulaca retuso Engelm. Purslane.
Grows very profusely on dams and cultivated grounds.
Portulaca pilosa Linn.
Common, but not so profuse as the species above.

Malvaceæ:
Malvastrum coccineum Gray. False mallow.

Linaceæ:
Linum sulcatum Ridell. Wild flax.
Dry soil; common (June 1).

Geraniaceæ.
Oxalis corniculata Linn. Yellow wood-sorrel.
Common.

Vitaceæ.
Vitis æstivalis Michx. (same grape, var. bicolor, LeConte).

Sapindaceæ.
Negundo aceroides Moench. Box-elder.
Common along streams.

Anacardiaceæ.
Rhus glabra Linn. Sumach.
Rhus copallina Linn. Dwarf sumach.
Rhus toxicodendron Linn. Poison-ivy.
Rhus trilobata Nntt. (R. canadensis, var. trilobata, Gray). Sumach.
The four Rhus species above are very common. The poison-ivy is found in the valleys, even away from the timber.

Leguminosæ.
Baptisia leucophæa Nutt. False indigo.
Tephrosia virginiana Pres. Goat's-rue.
Tephrosia?
Astragalus caryocarpus Ker. Ground plum (May–June).
Astragalus pattensis Nutt. (May 14.)

Astragalus missouriensis? Nutt.
Astragalus cooperi Gray. (May 14.)
Astragalus?
Astragalus villosus Michx. (May-June.)
Orobus atropurpureus? (May 14.)
Psoralea tenuiflora Pursh.
Psoralea argophylea Pursh.
Psoralea esculenta Pursh.
Desmanthus brachylobus Benth.
Found principally in semiwet places.
Schrankia uncinata Willd. Sensitive brier.
Very common on middle uplands.

Rosaceæ.
Prunus, like P. chicasa.
Numerous in thickets along stream (May 5).
Prunus rosebudii. Rosebud dwarf plum. (New species.)
Plant erect or decumbent, growing singly or in bunches from a common root stalk, six inches to one foot in height; leaves obovate-lanceolate; flowers two to four together; fruit ovoid, nearly black when ripe, sour and astringent in taste; stone large. Rocks and sandy banks.
Prunus virginiana Linn. Choke-cherry.
Banks; numerous.
Rosa humulis Marsh. Wild rose.
Everywhere; species very variable, flowers ranging in color from white to scarlet (June 18).
Rosa woodsii Lindl.
Rosa arkansana Porter.
Rosa rubiginosa.
The last three species are found on the reservation, the latter probably escaped from cultivation.
Cratægus coccinea, var. macracantha, Dudly. Hawthorn.
Only one specimen of this species was seen, at the head of Horse creek, about eight miles southwest of the White Thunder day school.
Ribes oxyacanthoides Linn. Gooseberry.
Not common.
Ribes floridum L'Her. Wild black currant.
Common on banks of streams (April 26).
Ribes aureum Pursh. Buffalo currant.
Common (April 20).

Onagraceæ.
Œnothera biennis Linn.
Œnothera pinnatifida Nutt.
Œnothera albicaulis Nutt.
Œnothera coronopifolia Torr. & Gray.
Œnothera parviflora Watson.
These Evening primroses are the most common flowers in the late summer and early fall, the flowers of the Compositæ family excepted.
Gaura coccinea Nutt.

Mentzelia nuda Torr. & Gray.
Mentzelia ornata Torr. & Gray.

Cucurbitaceæ.
Cicyos angulatus Linn.
Banks and damp, wooded ground.

Cactaceæ.
Mamillaria vivipera Haw. Cactus.
Mamillaria missouriensis Sweet.
Opuntia rafinesquii Engelm. Prickly-pear.
These three species of cactus are found on the dry prairies and the broken country.

Umbelliferæ.
Polytænia nuttallii Dc.
Everywhere in early spring (April 1).
Peucedanum fœniculaceum Nutt.
Peucedaneum villosum Nutt. (April 1).

Compositæ.
Erigeron annuus Pers. Daisy fleabane.
Ambrosia artemisiæfolia Linn. Hogweed.
Xanthium strumarium Linn. Cockle-bur.
Too common.
Chrysanthemum leucanthemum Linn. Whiteweed.
A pernicious weed everywhere.
Krigia virginica Willd. Dwarf dandelion.
Very common, usually flourishing best in the middle uplands.
Helianthus annuus Linn. Common sunflower.
Helianthus orgyalis Dc.
Helianthus grosse serratus Martens.
Helianthus maumiliani Schrader.
Helianthus subcanescens Gray.
Solidago nemoralis, var. incana, Gray. Goldenrod.
Cincus lanceolatus Hoffm. Common thistle.
Common on broken ground.
Bidens bipinnata Linn. Spanish needle.
Few and scattering.

Lobeliaceæ.
Lobelia inflata Linn. Indian tobacco.
Common; used as Indian medicine.

Oleaceæ.
Fraxinus americana Linn. White ash.
Moist woods.
Fraxinus pubescens Linn. Red ash.
Common along streams.

Asclepiadaceæ.
Asclepias cornuti Descaisne. Common milkweed.
Asclepias verticillata Linn., var. pumula Gray.

Boraginaceæ.
Echinospermum floribundum Lehm. Beggar-lice.
Echinospermum lappula Lehm.
Echinospermum redowskii Lehm.
The three lice-weed species are very common in the wooded dis
Lithospermum hirtum Lehm. Puccon.
Common.
Lithospermum angustifolium Michx.
Same as L. hirtum.

Convolvulaceæ.
Ipomœa purpurea Lam. Common morning-glory.
Escaped from cultivation (May 20).
Ipomœa leptophylla Torr. Wild morning-glory.
Common along watercourses.

Solanaceæ.
Solanum rostratum Dunal.
A common weed.

Verbenaceæ.
Verbena hastata Linn.
Verbena bracteosa Michx.

Labiatæ.
Isanthus cæruleus Michx. False pennyroyal.
Common.
Mentha canadensis Linn. Wild mint.
Common.
Hedonia hispida Pursh. Pennyroyal.
High, sandy points.
Salvia lanceolata Willd. Sage.
Very common.
Monarda punctata Linn. Horsemint.
Very common in the valleys.
Teucrium occidentale Gray.
Nepeta cataria Linn. Catnip.
Not common.

Plantaginaceæ.
Plantago major Linn. Common plantain.

Amarantaceæ.
Amarantus albus Linn. Tumbleweed.
Very common.

Chenopodiaceæ.
Chenopodium album Linn. Pigweed.
Cultivated grounds, everywhere.

Polygonaceæ.
Rumex acetosella Linn. Sheep-sorrel.
Rumex venosus Pursh.
Occasionally seen.
Rumex altissimus Wood. Pale dock.
Rumex crispus Linn. Yellow dock.
Rumex verticillatus Linn. Water dock.
Only one plant of this species was seen.

Aristolochiaceæ.

Shepherdia canadensis Nutt. Yellow buffalo-berry.

This species and the next are to be found in nearly all of the creek valleys of the reservation. The fruit is used much by the Indians. The whites also use it for making jelly, which they highly prize.

Shepherdia argentia Nutt. Scarlet buffalo-berry.

Utricaceæ.

Ulmus fluva Michx. Red elm.

Common along streams. It grows to be a large tree.

Ulmus americana Linn. White elm.

Not common.

Celtis occidentalis Linn. Hackberry.

Cannabis sativa Linn. Hemp.

Grows in barn-yards and cultivated bottom lands.

Humulus lupulus Linn. Hop.

Common along streams.

Cupuliferæ.

Quercus obtusiloba Wood. Post oak.

Common.

Quercus macrocarpa Michx. Bur-oak.

Banks. This species furnishes over half of the wood of the region.

Quercus macrocarpa, var. depressa, Engelm.

A dwarf species found in the deep, dry streams and ravines. It ranges in height from two feet to four feet.

Salicaceæ.

Salix amygdaloides Anders.

Salix rostrata Richardson.

Found on banks and at the water's edge along streams.

Salix longifolia Muhl.

This willow is found principally on White River flat. A bunch was found at the Ring Thunder day school.

Populus monilifera Ait. Cottonwood.

Borders of streams.

Populus heterophylla Wood.

Same as P. monilifera.

Coniferæ.

Pinus banksiana Lambert. Northern scrub-pine.

This tree is occasionally met with on the high points of the reservation.

Pinus pondorosa Dougl.

This tree is found on the high points and along the breaks of the Loup Fork (Arickaree) formation.

Juniperus virginiana Linn. Red cedar.

Robison bad lands and on all the other Miocene Clay bad lands of the reservation. It ranges from a scrub to a tree twenty to forty feet in height.

Iridaceæ.

Sisyrinchium angustifolium Mill. Blue-eyed grass.

Common (May and June).

Sisyrinchium anceps Cav. Blue-eyed grass.
Same as S. angustifolium.

Liliaceæ.

Nothoscordum striatum Kunth. False garlic.
Very common everywhere.

Yucca angustifolia Pursh. Bear-grass.
Very common, especially on the Miocene formation.

Polygonatum giganteum Deitrich. Great Solomon's-seal.
Common on low ground near the streams.

Smilacina stellata Desf. False Solomon's-seal.
Common in low, wet places (May 1).

Commelinaceæ.

Tradescantia virginica Linn. Spiderwort.

Juncaceæ.

Juncus effusus Linn. Common rush.

Typhaceæ.

Typha latifolia Linn. Cattail flag.

Gramineæ.

Bromus klamii Gray. Wild chess.

Setaria glauca Beauv. Foxtail.
Common in cultivated fields.

Cenchrus tribuloides Linn. Bur grass.
Sandy soil, found principally on the Arickaree formation.

Stifa viridula Tun. Feather-grass.

Agrostis vulgaris With. Redtop.
Scattering here and there.

Bouteloua oligostachya Torr. Grama-grass.
Found only in patches.

Buchloe dactyloides Engelm. Buffalo-grass.

Elymus canadensis Linn. Wild rye.

Poa tenuifolia?. Redtop buffalo-grass.
Very common.

Chrysopogon nutans Benth. Wood-grass.

Festuca ovina Linn. Bunch-grass.

Agropyrum repens Beauv. Bluejoint.

Calamagrostis canadensis.
Common in wet places.

Equisetaceæ.

Equisetum arvense Linn. Horsetail.
Ring Thunder Springs and in all the low, swampy places of the reservation.

Agaricus compestris.

Lycoperdon gigantum.

VI.

MATHEMATICAL AND PHYSICAL PAPERS.

"VARIATIONS OF LATITUDE."
By E. MILLER, University of Kansas, Lawrence.

"THE GENESIS OF GOLD IN MINERAL VEINS AND PLACERS."
By J. T. LOVEWELL, Topeka.

"THE GAS-ENGINE IN THE COMMERCIAL DEVELOPMENT OF KANSAS."
By P. F. WALKER, Lawrence.

"NOTE ON CERTAIN FORMULAS FOR THE DESIGN OF REENFORCED CONCRETE BEAMS."
By A. K. HUBBARD, Lawrence.

"EXAMINATION OF COAL-DUST AFTER EXPLOSIONS IN MINES OF SOUTH-EASTERN KANSAS."
By EDWARD BARTOW, University of Illinois, Urbana.

"THE FOUCAULT EXPERIMENT."
By J. T. LOVEWELL, Topeka.

"A DEEP WELL AT EMPORIA."
By ALVA J. SMITH, Emporia.

"THE INTERPRETATION OF INDICATOR DIAGRAMS."
By CHARLES I. CORP, Lawrence.

"A BIT OF ENGINEERING AT MOUNT VERNON."
By M. L. WARD, Ottawa University.

VARIATIONS OF LATITUDE.

By E. MILLER, University of Kansas, Lawrence.

THERE was published in the *Astronomical Journal* of November, 1891, an article on "The Variation of Latitude." Its author was Mr. S. C. Chandler, an American amateur in astronomy. The article attracted the attention of the astronomical world, and at once was subjected to fierce criticism from almost every quarter. To-day, however, the question is no longer an open one, for those who assailed it have, one by one, accepted it as established beyond a doubt.

In order to make clear what is to be said on the variation of latitude, it is necessary to go back about 200 years, to ascertain what was known and what was done along the line indicated by the title of this paper. In 1693 there was born, in Sherbourn, England, a child, James Bradley by name, who was to become one of the greatest of astronomers. He was one of those who are not content simply to amuse themselves with a telescope, but rather had the ambition to do earnest work, and the spirit to choose a problem which his predecessors for more than a century had failed to solve.

The Copernican theory that the sun is the center of the solar system and that the earth moves round the sun established a corresponding apparent change in the places of the stars. The absence of any appreciable change in the position of the fixed stars, when observed at opposite extremities of the earth's orbit, was one of the earliest objections, as well as the most serious one, that had been urged against the earth's motion; and it was always considered that the detection of such a change by observation would furnish absolute proof that the earth is not the center of the solar system. In the attempt to detect the annual parallax of the fixed stars, Bradley made his famous discovery of the aberration of light. Its discovery is universally regarded as one of the most important advances ever made in the field of astronomical science. The sagacity of Bradley in the establishment of this law, as well as in the detection of its physical cause, entitles him to a place among the greatest philosophers of ancient or modern times.

While at work investigating the phenomenon of aberration, Bradley found that some stars near the equinoctial colure had a greater

change of declination than a mean annual precession of fifty minutes would give. But on observing stars near the solstitial colure, the change of declination was found to be less than the quantity due to the same value of precession. During an interval of five years, he found some of the stars near the solstitial colure had changed their declination nine or ten minutes less than the amount due to a precession of fifty minutes, while others near the equinoctial colure had an equal change of declination in the opposite direction. Bradley was led to ascribe the phenomenon to an oscillation of the earth's axis, brought about by the disturbing action of the moon upon the earth's equator. He saw that the apparent movements of all stars were in this case the same, and he knew that a movement of this kind can be referred not to the stars themselves, but to the plumb-line from which their directions are measured. He had thought out the possible causes of such a movement of the plumb-line or of the earth itself, and that there might be a nutation which would go through a cycle of about nineteen years, the period of revolution of the moon's nodes.

At the end of nineteen years of observation Bradley found his conclusions verified, and his second great discovery, that of nutation, was established. Had he lived longer, a third great discovery might have crowned his efforts. He had presented to the astronomical world the discovery of the aberration of light; he had discovered the nutation of the earth's axis; he had found the physical causes of these two phenomena; and with a little more opportunity he might have added another great discovery, namely, the variation of latitude. The axis of the earth may move in one or two ways: either it may point to a different star, remaining fixed relatively to the earth, as in the case of nutation, or it may actually change its position in the earth. This second movement was not discovered until a century and a half had elapsed after the death of Bradley. But he was on the track that would have led him to its discovery. When he had fully established the principle of the nutation of the earth's axis, he found that there was concealed somewhere in his new-found theory another principle or residuum.

Now, as to the change of position of the earth's axis in the very body of the earth itself. There is a certain star in the northern heavens called the pole star, and at any particular place in the northern hemisphere of the earth this star is constantly seen at a definite height above the horizon, which is the latitude of the place. With a telescope, the pole star is found to be not absolutely stationary, but describes a small circle in the heavens every twenty-

four hours. The axis of the earth about which it rotates points to the center of that little circle, and any change can therefore be determined by observing the motions of the pole star. It is found, too, that the size of the circle increases or diminishes, thus indicating that the earth's axis is pointing farther away from the pole star, or nearer to it. This movement is due to precession, as has been known ever since the days of Hipparchus. The circle described by the present pole star is now getting smaller, but in the course of years it will increase in size, until after thousands of years it will cease to be the north star. Other stars, one succeeding the other, each at about twenty-three and one-half degrees from the pole, will become in turn the pole star.

Again, the center of the circle may change its position, and no longer be at the same height above the horizon of any given place. If this is true, then the earth's axis must be shifting in the earth itself; in other words, the north pole is not remaining in the same place. If the change in position should ever become a large one terrestrial climates would be subject to very great changes; but the truth is that the changes are small and the effect on climate is scarcely appreciable. Fifteen or twenty years ago no one believed that the north pole of the earth moved. Even the finest astronomical observations of that time failed to detect any such movement. Yet we have reached a point where the facts clearly show that the north pole does move—not very much, but still to an extent that is easily measured by astronomical observations.

Mr. Chandler found that there is a revolution of the earth's pole in 427 days, from west to east, with a radius of thirty feet, measured at the earth's surface. He assumed, for the purpose of statement, that this is "a motion of the north pole of the principal axis of inertia about that of the axis of rotation; the direction of the former from the latter lay towards the meridian of Greenwich about the beginning of the year 1890. This, with the period of 427 days, will serve to fix approximately the relative positions of these axes at any other time for any given meridian." This was in flat contradiction to all accepted views. The only period in which the earth's pole could revolve was believed at that time to be ten months. The radius of its path had been declared to be insensible, and now comes Mr. Chandler affirming that the period was a variable one, and that the path had a radius of thirty feet.

In confirmation of his theory, an examination of the observations of a German astronomer, of Berlin, furnished Mr. Chandler another fact, namely, when the Cambridge, United States, latitudes

were the smallest, those of Berlin were the largest; that is to say, if the north pole moved nearer America, it must move further from Europe; and, on the other hand, if further from America, then nearer Europe. There was something perplexing about these movements, as they had been known for a long time, but no satisfactory solution had been given. Mr. Chandler solved the problem, and the difficulties were removed.

To show that there is a deviation of the earth's pole from its average position, two tables, prepared by Chandler, showing the distances of the earth's pole, in feet, from its average position, are herewith given, each representing a year's observations. The signs plus and minus indicate opposite directions of displacement. The first table was made at Washington, D. C., and the other at Pulkowa, near St. Petersburg.

Washington.		*Pulkowa.*	
December, 1864	−28 feet.	July, 1865	−18 feet.
March, 1865	− 1 "	September, 1865	+ 3 "
June, 1865	+15 "	November, 1865	+26 "
August, 1865	+22 "	February, 1866	+18 "
October, 1865	+11 "	June, 1866	−11 "
December, 1865	−17 "	July, 1866	−16 "

The figures are not exact in every case, but the error in them is always a very small one. Every expert astronomical observer knows how difficult a matter it is to obtain the position of the earth's pole to within a foot.

Mr. Chandler's investigation of the results reached by other astronomers, and comparing them with his own, arrived at the conclusion that there was, besides the vibration of the earth's axis in the body of the earth, also an increase in the period of polar revolution. At the time of Bradley's observations the period was shorter by about two months than it is now. Whether this movement is subject to a periodicity, reaching at one time a maximum and then a minimum, is not yet determined. But it is certainly known that at times there are very irregular movements, due to some cause or other, followed by others that are subject to a periodicity.

Chandler says: "Another characteristic which has struck my attention, although somewhat vaguely, is that the variations in the length of the period seem to go hand in hand with simultaneous alterations in the amplitude of the rotation; the shorter periods being apparently associated with the larger coefficients for the latter."

Almost all of the series of observations of any extent which

have been examined are peculiar in that they manifest the periodicity quite uniformly and distinctly for a number of years, then for a while irregularly and obscurely.

Simon Newcomb, one of the greatest of living astronomers, in his discussion of Chandler's theory, writes as follows:

"Mr. Chandler's remarkable discovery, that the apparent variations in terrestrial latitudes may be accounted for by supposing a revolution of the axis of rotation of the earth around that of figure, in a period of 427 days, is in such disaccord with the received theory of the earth's rotation that at first I was disposed to doubt its possibility. But I am now able to point out a *vera causa* which affords a complete explanation of this period. Up to the present time the treatment of this subject has been this: The ratio of the moment of inertia of the earth around its principal axis to the mean of the other two principal moments admits of very accurate determination from the amount of precision and nutation. This ratio involves what we might call, in a general way, the solid ellipticity of the earth, or the ellipticity of a homogeneous spheroid having the same moments of inertia as the earth.

"The question now arises whether Mr. Chandler's result can be reconciled with dynamic theory. I answer that it can, because the theory which assigns 306 days as the time of revolution is based on the hypothesis that the earth is an absolutely rigid body. But, as a matter of fact, the fluidity of the ocean plays an important part in the phenomenon, as does also the elasticity of the earth. The combined effect of this fluidity and elasticity is that if the axis of rotation is displaced by a certain amount, the axis of figure will, by changed action of the centrifugal force, be moved toward coincidence with the new axis of rotation. The result is, that the motion of the latter will be diminished in a corresponding ratio, and thus the time of revolution will be lengthened. I think the result of investigation will be that the rigidity derived from Mr. Chandler's period is as great as that claimed by Lord Kelvin from the phenomena of the tides."

Mr. Chandler himself says: "It is unnecessary for the purpose of disposing of objections to insist that it is not sufficient to show that the observed variations, attributed to the unsteadiness of the earth's pole, are near the limit of precision attainable in linear differential measures, and in the indication of the direction of gravity by means of the air-bubble of the level; or to show that there are known variations in divided circles and in levels, dependent on temperature and seasons. Nor need we even urge the fact

that a large portion of the data which have been utilized in the present researches on the latitude were derived by methods which dispense with levels, or with circles, a part of them indeed with both, and yet that the results of all are harmonious. On the contrary, let us admit, although merely for argument's sake, that all the known means of determining the direction of gravity are subject to a common law of periodical error which vitiates the result of astronomical observation, obtained by whatever methods, and in precisely the same manner. Now, the observed law of latitude variation includes two terms, one a period of fourteen months, and the other of twelve. Since the phases of the first term are repeated at intervals of two months in successive years, and hence in a series of years come into all possible relations to conditions of temperature dependent on season, the argument against the reality of the fourteen months' term absolutely fails."

Heretofore the observations made by astronomers in Europe and America, in all of which there was some puzzling error, were immediately rectified when Mr. Chandler applied his new rule to them. The constant of aberration has been wonderfully improved, but there is room yet to secure greater accuracy.

Again, if the axis of the earth is making small oscillations of this kind, there should be an effect upon the tides. The ocean should feel the swinging motion of the earth's axis in some way. The tidal registers show that there is a distinct effect. The rise and fall of the tide are only a few inches, but they are evidences of an irresistible character that the earth is turning around in an unbalanced vibration. The vibration at one time is waxing and at another waning.

In conclusion, it may be said that in the consideration of this subject we find that when Bradley, 160 years ago, began to work out the problem of parallax, he was led to the discovery of the "aberration of light," and finding that an uncertain element persisted in presenting itself at every turn of his work, he was led to the discovery of the nutation of the earth's axis. But even at this point he found another difficulty remaining over. Death cut short the work of the great astronomer. Twenty years ago the work was resumed by an American. Now it is an accepted fact that not only does the earth's axis spin around, according to the theory of nutation, but there is another and stronger motion of the earth's axis, and that is, that there is an actual change of the position of the earth's axis in the earth itself, causing the latitude of the earth to change at every point on its surface.

THE GENESIS OF GOLD IN MINERAL VEINS AND PLACERS.

By J. T. LOVEWELL, Topeka.

IN our limited sphere of observation we can know but little of the internal structure of the earth. Assuming it once to have been a molten liquid mass, it is natural to conclude that the denser constituents would be grouped nearest the center, and as the earth cooled, and as rifts were made by contraction of the solid crust down to the liquid interior, the molten rock extruded through these cracks would contain more of the heavy metals. Were the fissure deep enough the outflow might be metals like gold or platinum, or even heavier substances, unknown on the earth's surface.

The hypothesis of a liquid interior has little to support it, and whatever may be the temperature it is certain that the earth's interior is a mass of great rigidity, and we can form little conjecture how its elements are combined and grouped.

The fact of rifts in the crust may be admitted, and that these were ways of exit of a molten magma which filled the crevices and flowed out as it does to-day in volcanoes.

But these fissures are filled not only with igneous rock but with materials crystallized out of solutions. One of the commonest of these crystallized substances is quartz, either alone or intermixed with oxides, sulfides, etc., of various metals, or with the metals uncombined, as gold and silver. The solvent which carried this silica and these metals is doubtless water, which comes nearest of any liquid to being the universal solvent. In explaining earth problems we must always keep in mind the ever-present water, which, first enveloping the earth as a vapor, must have been continually exerting its solvent powers on whatever was beneath and around it. Not only does it act on surfaces but it penetrates the interiors of substances, and its energy is increased by the gases, such as chlorine, with which it may be saturated, and by the high temperature, at which it must always have existed.

If we start now with the situation when the igneous rocks and crystallizations fill the fissures and outcrop on the surface of the earth, we find the water acting in another role. It is now to grind down the surface by glacial action, to plow out the valleys by erosion, and to sift the fine from the coarse, the heavy from the light, till the deposits are brought to their present condition. The gold

deposits of Cape Nome, of the Rand and of innumerable placers are the results of these actions of the waters in their grinding, carrying and sifting capacity.

As already intimated, the gold found in quartz fissure veins may have been deposited with the silica from the water.

We may inquire, then, whether the seas, which cover a large part of the earth's surface, still carry gold in solution.

On authority of the English chemist, Liversidge, a ton of sea-water contains on an average one grain of gold. If this be true, we can calculate the amount of gold in the waters of the sea. Chamberlain and Salisbury, in their recent text-book on geology, estimate the quantity of sea-water at 1300 quadrillion tons. This, then, is the number of grains of gold spread abroad in the sea. The number of grains in a cubic foot of gold is, approximately, 8,312,500. The total number of grains, divided by this, gives 15,639,218,045, the number of cubic feet of gold dissolved in the waters of the sea. This more than equals a cube of gold 2500 feet on each edge.

This universal distribution of gold in water is accompanied by its almost equally general occurrence in mineral deposits, and perhaps accounts for the latter fact. In studying the physical aspects of the earth, we are apt to look upon it as a completed structure, and we think of the great changes revealed to us in geology as having no counterpart in the present time. A moment's reflection will convince us that earth changes are yet going on by which the structure may be altered as much as it has been in past eons.

As to the possibility of gold veins and placers being even now in the process of formation, we have some evidence to support such a hypothesis. In the University of California Bulletin, vol. 4, No. 10, John A. Reid discusses the origin and genesis of the Comstock lode. He treats of the geological formation and development of the Comstock lode mines, and comes to certain conclusions as to the part water has played in the "bonanzas" of these rich veins. The primitive vein of gold-bearing mineral has had the gold leached out of it, as it were, to be redeposited in secondary veins, which become thereby extremely rich in gold, and this investigator thinks the process may be still going on in the deeper levels of the mine. He finds by analysis of the vadose water of the mine a percentage of gold greater than sea-water contains, and the deposit of the metal in newly opened fissures is easily seen possible.

What is going on in the Comstock mine may have its counterpart in other veins, known or undiscovered, and suggests the

thought that in future ages gold veins may be worked where the gold at this present time is not deposited.

In this paper the inquiry has been limited to gold, but it is easily seen that similar conclusions could be reached respecting other metals, and that water has had an important part in determining the location and condition of ore deposits. We can find near the surface of the earth all the material needed to supply the mineral veins, and it is unnecessary to suppose that the heavy metals must have come from great depths.

THE GAS-ENGINE IN THE COMMERCIAL DEVELOPMENT OF KANSAS.

By P. F. Walker, Lawrence.

THE state of Kansas is well situated with reference to the great producing sections of the country for the establishment of important manufacturing interests in cotton and woolen fabrics, boots, shoes, and leather novelties, and has itself mineral resources of various kinds not yet fully developed, and which are now being shipped as raw rather than as finished products. With these advantages of location, and native resources in material to be wrought upon, are valuable deposits of coal, oil and gas for fuel, building materials of the very best quality, a soil capable of supporting a far greater population than the liveliest imagination has pictured, and a climate well suited to attract the earnest home-seeker. The question, then, may be seriously considered if a fair proportion of these raw materials may not well be expected to be worked upon here in the not far distant future, instead of their being shipped far into the Northern and Eastern states and then back again, in great part for final consumption by those who are working to send food on its long journey to pay the debt.

There are three conditions which must be favorably met before business interests of the kinds indicated can be successfully established. When once it is demonstrated that they are favorable here in Kansas, the necessary capital will come unbidden, and there will set in a new era in industrial development. These three conditions are: First, efficient and economical transportation facilities, both to the mills and to the markets; second, a supply of competent labor; and, third, an abundant and economical source of power. Other special conditions may sometimes arise, as, for instance, the necessity for a supply of clear water, to be used in the manufacturing process; but the three general conditions must always be met.

In respect to transportation the state is peculiarly fortunate, and better conditions could hardly be desired. This is especially true because of the fact that the power to be depended upon is not scattered over the country at falls in the watercourses, but the mills may be located at will on trunk railroad lines.

The labor condition is a serious one. Practical mill men have expressed the opinion to the writer that this is the greatest obstacle

to be overcome in locating the textile mills and boot and shoe manufactories in a new country. Operatives must acquire a certain skill, requiring time and patience, and a tolerable acute intellect, and the surroundings in which they work are trying to the constitution, particularly for those who have been accustomed to an outdoor life. Those who have been reared in the atmosphere of the mills—often too literally so, in the absence of restrictions on child labor—make competent workers, but they shrink from going into a distant field, where the number of mills is small and changes of situation not easily effected, since they are inclined to make frequent changes. In the movement to establish cotton-mills in the Southern seaboard and Gulf states, which has been successful, dependence has been placed on the white people of the mountain sections to supply the demand for labor. It seems doubtful if there is a class in Kansas that will take kindly to the work, and it will take time to develop a mill population.

In the consideration of power we come to the real subject-matter of this paper. The demand for power in nearly all of the industries referred to is considerable, and serious variations in the cost of power affect the dividend-paying possibilities to a considerable extent. For illustration, we may take a cotton-mill of 50,000 spindles, which will produce 25,000,000 yards of dress goods of average weight per annum, and compare power costs when driven by water power and when driven by steam-engines. This mill will require an invested capital of about $750,000. It will require 1800 horse-power to run the machinery. The average cost of water power, when available for direct application, is about $12.50 per horse-power per year at the New England mills, giving a total annual cost of $22,500. For the steam-driven mill we will assume a first-class type of compound condensing engine, good boilers, and a high-grade coal, costing $5 per ton delivered on the boiler-room floor. The first cost of installation will be about $52 per horse-power—not materially different from that of the water plant. Allowing five per cent. of cost of machinery to cover the items of depreciation and repairs, a fuel consumption of two and one-fourth pounds of coal per horse-power per hour, and $3000 per year for labor in the engine- and boiler-rooms, we have, for a year of 300 days of ten hours each, a total cost of nearly $38,000, which is $15,500 more than the cost of water power. This difference is 2.1 per cent. of the total investment, and is a direct inroad on dividends, being enough to effectually prohibit operations in many cases.

Now, then, what are the possibilities here in Kansas?

Before leaving the question of water power it will be well to consider briefly one phase of the matter that may become of importance. Water-power privileges are not numerous in Kansas, but there are a few points where power in large amounts could be produced, and from it electric power be generated directly and transmitted at high voltage to convenient points for the establishment of mills, where it can be used through the medium of electric motors. This method of power utilization is now being extensively employed throughout the country, and a plant is now in process of construction in the southeastern part of Kansas to supply power to three different towns in that section. With this form of service, assuming that the central plant furnishes power to the equivalent of three mills like our type, and that power is transmitted twenty-five miles, the increase in the first cost of the mill would be about $70,000, this being approximately one-third of the cost of the electrical machinery and building at the central station, the transmission line, and motors to run the mill. The increase in the actual cost of the power will be made up of two items: First, the additional water power to make up for the losses in changing to electrical and back to mechanical power, and the direct loss in transmission; second, depreciation and repairs on the electrical equipment, which will be a larger amount than in the case of the steam machinery. Taking the power loss as twenty per cent., we have 360 horse-power at $12.50, or $4500, in the first item. Depreciation and repairs may be taken at six per cent. on $56,000, which is the cost of the electrical machinery alone, giving $3360 in the second item. The total increase of power cost over that for water power applied directly is thus $7860, *or about one-half that for steam power.* Dividends must in this case be paid on an investment nearly ten per cent. greater, however, so that the actual decrease in the rate will be nearly *1.5 per cent.* Undoubtedly this figure can be bettered by the use of electricity for other purposes than running the machinery, or by sale to other parties. This is true particularly in those establishments where portions of the machinery are run during only a part of the time, since individual motors may be used on the machines or groups of machines, and so save the power to drive long lines of idle shafting. In fact, it is often found desirable to use this electric-motor system when the power plant is located directly at the operating plant, in order to save driving so much idle machinery, and when there are several buildings this system is by far the best possible in the great majority of cases, whether water or steam is the prime power.

In this state, however, the power to be depended upon is that transformed from the heat energy stored in the fuels that are available through the agency of some form of heat engine. There are two general classes of these engines. In one the heat of the fuel is applied to some liquid, usually water, in a separate vessel, or boiler, and the vapor thus formed is led to the working cylinder of the engine, where it gives up its heat to produce the energy of moving machine parts. The steam-engine with its boiler is the only practical example of this class. It may use any fuel, as coal, oil, or gas, that will supply the heat. In the other class the fuel is taken into the working cylinder of the engine proper with a supply of air, and there burned. The heat so generated is applied directly to the air present, which with the burned gases forms the working fluid. Of this class the most prominent types are the gas-engine, the oil-engine (using crude petroleum directly), the gasoline-engine, and the kerosene-engine. They are designated as internal-combustion engines.

The fuel used by the gas-engine may be natural gas, artificial gas from the producer used for general gas production, or that from a special form of suction-gas producer, in which the engine in drawing in its fresh charge of air and gas furnishes the draught necessary to maintain combustion in the producer. This last system is becoming popular, due to its economy in operation and the compactness and unity of the plant. Several electric generating plants using this system have been installed in this state during the last few years, and more are in process of erection. The fuel used in the producers now in operation is anthracite coal, but at least one company is now perfecting plans for a producer adapted to the use of the bituminous coal mined in this section of the country. This system is of the greatest importance, since it insures the permanence of the gas-engine so long as the coal supply holds out. Natural gas is good where it may be had and as long as it lasts, but it can hardly be considered as a permanent fuel, and could not be accepted as fulfilling the condition for an abundant source of power.

The oil-engine, using crude petroleum directly as a fuel, has been brought out in the United States in a really satisfactory form by only one company. In this form it is a German design, controlled by the Diesel Motor Company, of New York, and built by the American and British Manufacturing Company in Providence, R. I. In operation, the oil is pumped under high pressure into the engine cylinder, in which air has been compressed to a pressure of 500 pounds to the square inch. The oil is forced in against this

pressure in such a manner that it is sprayed on entering, and the high temperature produced in the air by the compression is sufficient to ignite it. Its cycle is the nearest approach to the ideal cycle first demonstrated by Carnot, the distinguished French scientist and engineer, that has ever been secured in engineering practice. The engine is very efficient and is meeting with a good demand, mostly for use in electric-generating plants, which is the most exacting service to be met. So long as the petroleum supply remains abundant it must be considered as an important prime mover, and in this respect is far superior to the gas-engine using natural gas. Since the fuels used in the two remaining types of internal-combustion engines, namely, gasoline and kerosene, are products of petroleum and comparatively expensive, those forms are not to be considered, excepting at isolated points where small powers are needed.

As machines these two internal-combustion engines which we may consider seriously in the present connection, namely, the gas- and oil-engines, are compact and well constructed, occupying small space in proportion to the power. All are probably familiar with small types of the gas-engine, and it may be that many have in their minds the idea of a small, noisy, and, perhaps, "cranky" affair, which features are sometimes characteristic of the type. An inspection of a large modern engine would do much to dispel that idea. The small engine usually works with but one effective impulse from the combustion or explosion of the gas in two complete revolutions, according to the so-called Otto or four-stroke cycle. This necessitates a very heavy balance-wheel, and increases the difficulties of governing the speed, but it is very generally accepted as the best method of securing efficient utilization of the heat energy of the gas. When large powers are necessary, two or more engines are usually connected to the same shaft, and set so that their impulses alternate, thus securing more uniform expenditure of energy, and making possible extremely accurate governing of the speed. Both vertical and horizontal types are successfully employed.

The latest designs of large power engines by the Westinghouse Machine Company are strikingly similar in general appearance to some makes of tandem compound high-speed steam-engines, excepting for the nature of the valve gear. They have two cylinders in line, with pistons on the same rod, and both cylinders double acting. Hence, instead of having but one impulse in two revolutions or four strokes, each cylinder gives one impulse every two

strokes, and, both together, an impulse for each stroke, or two for each revolution. This places it on a par in this respect with a single-crank steam-engine, and the governing features are good for any service. In the largest sizes it is made still better, however, by having two cranks and rods, with two pairs of cylinders, the cranks being set at ninety degrees with each other, by which method four impulses per revolution are secured. Engines of the single-crank type are made in powers ranging from 200 to 2000 horse-power, and of the double-crank type from 400 to 4000 horse-power. Since very high temperatures are produced in all gas-engines during combustion, sometimes as high as 2800 or 3000 degrees Fahrenheit, which is above the melting-point of cast iron, water circulation in all parts exposed to the heat is necessary, and in the double-acting engines this cooling of the enclosed pistons presents some difficult features in design.

The Diesel oil-engine is built in vertical form, with either two or three cylinders and sets of moving parts, and in general appearance resembles a marine steam-engine. Each cylinder is single acting, giving one impulse in two revolutions, so that the engine as a whole gives either one or one and one-half impulses per revolution, which insures good governing features. The maximum temperature in the cylinder is not far from 1400 degrees Fahrenheit, which is that resulting from the preliminary compression, since the admission of fuel oil is so regulated that it burns during expansion without rise in temperature. The engine is built at present in sizes ranging from 75 to 225 horse-power, but may be readily doubled up on the same shaft and so double the range of power.

As efficient converters of heat into mechanical energy these engines may well be studied in comparison with the steam-engine, since it is with the latter that they come into competition. In this comparison a compound condensing steam-engine will be taken as the type representing the class in large manufacturing plants and for power-station service. A good type of steam-boiler will utilize from 70 to 75 per cent. of the heat in the fuel, as equipped and operated in first-class establishments. The engine of the kind in question will utilize from 14 to 15 per cent. of the heat coming to it in the steam in general service, or 10 to 11.2 per cent. of the total heat value of the fuel burned. The bulk of the remainder of the heat is carried away in the cooling water in the condenser and up the flue from the boilers. The gas- and oil-engines, on the other hand, work with a thermal efficiency of from 17 to 25 per cent., with possibilities of still better results.

As desirable forms of prime movers in commercial plants the gas- and oil-engines must be subjected to complete analysis that shall include all conditions of first cost, depreciation, repairs, and labor, as well as fuel cost. This we will now proceed to do with our typical cotton-mill.

A single gas-engine of 1800 horse-power, to use natural gas, may be purchased for about $43 per horse-power; foundations will cost about $7; making the total cost of the engine, erected, $50 per horse-power, or $90,000. This is somewhat less than the average first cost of a water-power plant, but the difference is not likely to be enough to influence appreciably the total investment in the mill. Depreciation may be taken at four per cent. and repairs three per cent. on $90,000, giving $6300 annually. Labor for attendance, one man, at $750 per year. Gas consumption will be about ten cubic feet per horse power per hour, or 54,000,000 cubic feet per year of 3000 hours. With gas at 25 cents per 1000 cubic feet, the fuel bill will be $13,500, and hence the total annual cost of power, $20,550. This, when compared with the preceding calculations, giving $22,500 for water power and $38,000 for steam power, shows well for the gas-engine. When installed with a suction producer, using coal for fuel, conditions will be different. Actual figures for cost of producers of this capacity are not available, but $10 per horse-power will be a safe figure, which, with $2000 added to the cost of the engine to provide for the slightly increased size necessary when used with the suction producer, makes the total cost of the apparatus $110,000. It will be assumed that Arkansas anthracite coal will be used, at $6 per ton, and that the rate of fuel consumption will be 1.25 pounds of coal per horse-power per hour, which is a liberal figure. This gives 3375 tons of coal burned per year, at a cost of $20,250. Depreciation and repairs will be increased to seven per cent. of $110,000, or $7700, and labor increased by two men, at $450 each per year, making total labor $1650 per year. This makes the total cost of power $29,600 per year, or $7100 more than the cost of water power. This excess is, however, but forty-five per cent. of that occurring with the use of steam, and is $760 less than that with water power with electrical transmission and motor drive. As already noted, however, the power cost with the latter system may be reduced under favorable conditions; so it may fairly be stated that costs are about the same for the hydro-electric system and the gas-engine with suction producer.

The first cost of the gas equipment is $50,000 less, however; so that there would be a difference in dividends in its favor of over

0.5 of one per cent., while there would be a difference of less than one per cent. between it and directly applied water power in New England. Freight differences on raw materials would probably more than counterbalance this difference, so that the cotton-mill in Kansas will be on the same plane with the New England mill as betwen power cost and freight, while with natural gas at 25 cents per 1000 cubic feet it will be better off on power alone by 0.2 of one per cent. in dividends.

It is almost useless to make calculations for power costs from crude petroleum as a fuel. The price is subject to great fluctuation, and if it should be adopted to any very considerable extent in manufacturing plants it is extremely doubtful if the supply would be adequate, in view of the great demand for the lighter distillates, and in any case the price would greatly increase. Under present conditions in Kansas it offers great advantages as a substitute for coal, especially when used in the oil-engine.

In point of economy in fuel consumption there can be no doubt as to the superiority of the gas- and oil-engines over the steam-engine. This does not mean that the latter is to be at once relegated to the junk heap, however. At the present stage in the development of the internal-combustion engine, its small financial advantage, as shown in the preceding calculations, is often offset by the practical usefulness of steam in auxiliary service, to say nothing of the advantage accruing from the familiarity of operating engineers with the older type.

As it has taken a century and a quarter to develop the steam-engine since it first assumed its practical form in the hands of Watt; so must more time be given to perfect this later type of prime mover which first appeared in really successful operation in 1876. The gas-engine is now passing through a transitional period, while it is coming into prominence as a real factor in the larger business interests of the world. The new form of Westinghouse engine already described shows the manner in which the type is progressing, following instinctively the path of progress marked by the steam-engine, but standing as a more economical machine. It is moving far more rapidly than did the steam machine, and even now, as the latest and most improved steam motor, the turbine, is being perfected and successfully established as a positive step in advance, prominent European scientists and at least one of the prominent engine-building companies of this country are working on the gas-turbine, which we may expect to see making its appearance in the

near future as the latest and most refined result of scientific engine designing of the age.

The commercial development of Kansas of which we speak belongs to the future, perhaps not far distant. The present narrow margin in favor of the gas-engine will be made larger as time goes on, principally by a reduction in the fixed charges for depreciation and repairs, resulting from standardized forms and lower first cost, since the present prices for the engine are abnormally high. Operating engineers are gradually becoming acquainted with it, which in itself will insure increased favor, and there can be no doubt but that in this form of motor Kansas, and other similarly situated states, will find the source of power that will serve in the permanent advancement of the manufacturing interests.

NOTE ON CERTAIN FORMULAS FOR THE DESIGN OF REENFORCED CONCRETE BEAMS.

By A. K. Hubbard, Lawrence.

IN chapter II of the book on Reenforced Concrete, by A. W. Buel and C. S. Hill, some formulas and deductions are given which are incorrect. It is the object of this paper to point out the mistakes in these formulas and deductions, and to illustrate the errors involved by numerical examples.

Before proceeding to a consideration of the formulas, it will be well to notice the assumptions on which the formulas are based. It is not proposed to enter into any discussion concerning the correctness of these assumptions:

1. The strain of any fiber is directly proportional to the distance of that fiber from the neutral axis of the beam.

2. The stress in any fiber is proportional to its distance from the neutral axis.

3. Any variation of stress or strain near the reenforcement is neglected.

Referring to figure 1, the author uses the following notation:

M = bending moment in inch-pounds.
l = length of beam in inches, center to center of supports.
h = depth of beam in inches, out to out concrete.
b = breadth of beam in inches.
A = total area of cross-section of beam = hb.
A_s = area of steel reenforcement in tension.
A_s^1 = area of steel reenforcement in compression.
$A_c = A - (A_s + A_s^1)$ = area of concrete.
x = distance from neutral axis to outer compression fiber of concrete.
y = distance from neutral axis to outer tension fiber of concrete.
u = distance from neutral axis to outer compression fiber of steel.
z = distance from neutral axis to outer tension fiber of steel.
t = distance from neutral axis to center of steel sections in compression.
v = distance from neutral axis to center of steel sections in tension.
$y = z + d$; $x = u + d^1$; $h = x + y$; $h^1 = u + z$; $h^{11} = t + v$; $y = v + d_1$; $x = t + d_1^1$.

I = moment of inertia of reenforced beam about its neutral axis $= I_s + I_c$.
I_s = moment of inertia of steel about neutral axis of beam.
I_c = moment of inertia of concrete about neutral axis of beam.
E_s = modulus of elasticity of steel.
E_c = modulus of elasticity of concrete.
$e = \frac{E_s}{E_c}$.
f_s = maximum intensity of tensile stress in steel.
f_s^1 = maximum intensity of compressive stress in steel.
f_c = maximum intensity of tensile stress in concrete.
f_c^1 = maximum intensity of compressive stress in concrete.
L_s = load sustained by steel.
L_c = load sustained by concrete.
s = proportion of load sustained by steel.
c = proportion of load sustained by concrete.

The steel reenforcement may consist of one or any number of bars, of any cross-section on both sides of the neutral axis or on the tensile side only.

After stating a number of formulas relating to the bending moment on beams, which have no bearing on the subject of this paper, the author gives these formulas without any deductions:

(1) $$y = \left\{ \frac{bh^2}{2} + \left[A_s d_1^2 + A_s^1 (h - d_1^1)^2 \right] (e-1) \right\} + \left[A + (A_s + A_s^1)(e-1) \right]$$

(2) $$x = h - y$$

(3) $$z = y - d$$

(4) $$u = x - d^1$$

(5) $v = y - d_1$ where $d_1 = d +$ radius of steel.

(6) $t = x - d_1^1$ where $d_1^1 = d^1 +$ radius of steel.

(7) $I_s = A_s v^2 + A^1_s t^2 +$ (the moments of inertia of the steel bars about their individual neutral axes, which may be neglected for small rods without appreciable error).

(8) $$I_c = \frac{bh^3}{12} - \left(A_s v^2 + A_s^1 t^2 \right)$$

The distribution of the load between the concrete and the steel will be:

(*9*) $$\frac{L_c}{L_s} = \frac{E_c I_c}{E_s I_s} = \frac{I_c}{e I_s} = g$$

(*10*) $$c = \frac{g}{1+g} \text{ and } s = \frac{1}{1+g}$$

(*11*) $$M = \frac{I_s f_s}{z s}$$

(*12*) $$M = \frac{I_s f_s^1}{u s}$$

(*13*) $$M = \frac{I_c f_c}{y c}$$

(*14*) $$M = \frac{I_c f_c^1}{x c}$$

If $f_c = 0$, that is, if the concrete does not resist tensile stresses—the condition that exists after the concrete has failed in tension, but before the ultimate resistance of the reenforced beam has been reached—we have: (*15*)

$$x = -\frac{e}{b}\left(A_s + A_s^1\right) + \sqrt{\frac{e^2(A_s + A_s^1)^2}{b^2} + \frac{2e}{b}\left[A_s^1 d_1^1 + A_s(h'' + d_1^1)\right]}$$

(*16*) $$I_c = \frac{bx^3}{3}, \text{ nearly, if } A_s \text{ and } A_s^1 \text{ are small.}$$

(*17*) $$I_s = A_s v_2 + A_s^1 t^2, \text{ nearly.}$$

If $A_s^1 = 0$, that is if the steel reenforcement is on the tensile side of the neutral axis only,

(*18*) $$x = -\frac{e}{b} A_s + \sqrt{\frac{e^2 A_s^2}{b^2} + \frac{2e}{b} A_s(h'' + d_1^1)}$$

(*19*) $$I_c = \frac{bx^3}{3}, \text{ nearly, if } A_s \text{ is small.}$$

(*20*) $$I_s = A_s v^2, \text{ nearly.}$$

Proceeding now to an examination of some of these formulas in detail, a value for y of (*1*) can be found as follows:

If the rods are small, f_s and f_s^1 may be taken as the intensity of stress throughout the entire section of the rods in tension and compression, respectively.

For equilibrium:

The sum of the compressive stresses = the sum of the tensile stresses, or symbolically,

$$F_c = F_t \qquad (1)$$

Let C_c and C_t equal the compressive and tensile stresses in a concrete beam of the same dimensions as the reenforced beam.

Let S_c and S_t equal the excess of stress in the steel over that in the same area of concrete in the same position in the beam.

Then (*1*) may be expressed

$$C_c + S_c = C_t + S_t \qquad (2)$$

$$\text{Now } C_c = \frac{bxf_c^1}{2} \qquad (3)$$

$$S_c = f_s^1 A_s^1 - \left(\frac{x-d_1^1}{x} f_c^1\right) A_s^1 \qquad (4)$$

$$C_t = \frac{byf_c}{2} \qquad (5)$$

$$S_t = f_s A_s - \left(\frac{y-d_1}{y} f_c\right) A_s \qquad (6)$$

Substituting these values in (*2*)

$$\frac{bxf_c^1}{2} + \left[f_s^1 A_s^1 - \left(\frac{x-d_1^1}{x} f_c^1\right) A_s^1\right] = \frac{byf_c}{2} + \left[f_s A_s - \left(\frac{y-d_1}{y} f_c\right) A_s\right] \qquad (7)$$

Now, since by our assumption the strain in any fiber is proportional to its distance from the neutral axis, and since $\frac{F}{A} = \frac{\lambda E}{l}$, λ A and l remaining the same for either material at a given position in the beam, $\frac{F}{A}$ must vary as E, A representing any area under consideration.

Now for steel in tension $\frac{F}{A} = f_s$

For steel in compression $\frac{F}{A} = f_s^1$

For concrete in tension $\frac{F}{A} = \frac{y-d_1}{y} f_c$

For concrete in compression $\frac{F}{A} = \frac{x-d_1^1}{x} f_c^1$

at those distances from the neutral axis at which the reenforcing rods are placed.

From the foregoing: $\dfrac{f_s^1}{\frac{x-d_1^1}{x} f_c^1} = \dfrac{E_s}{E_c}$

$$\text{or} \quad f_s^1 = \frac{x-d_1^1}{x} f_c^1 e \qquad \text{since} \quad e = \frac{E_s}{E_c}$$

$$\text{Similarly} \quad f_s = \frac{y-d_1}{y} f_c e$$

Substituting these values of f_s^1 and f_s in (7) we have:

$$\frac{bxf_c^1}{2} + A_s^1 \left[\frac{x-d_1^1}{x} f_c^1 (e-1)\right] = \frac{byf_c}{2} + A_s \left[\frac{y-d_1}{y} f_c (e-1)\right] \qquad (8)$$

Dividing by f_c^1 and remembering that $\frac{f_c}{f_c^1} = \frac{y}{x}$

$$\frac{bx}{2} + A_s^1 \frac{x-d_1^1}{x}\left(e-1\right) = \frac{by}{2} \cdot \frac{y}{x} + A_s \frac{y-d_1}{y} \cdot \frac{y}{x}\left(e-1\right)$$

Or,

$$\frac{bx^2}{2} + A_{s1}\left(x-d_1^1\right)\left(e-1\right) = \frac{by^2}{2} + A_s\left(y-d_1\right)\left(e-1\right) \qquad (9)$$

Substituting for x, its value $h-y$

$$b(h-y)^2 + 2A_s^1(h-y-d_1^1)(e-1) = by^2 + 2A_s(y-d_1)(e-1). \qquad (10)$$

Solving this equation for y gives

$$y = \frac{\frac{bh^2}{2} + [A_s d_1 + A_s^1 (h-d_1^1)](e-1)}{A + (A_s + A_s^1)(e-1)}$$

which is the correct value of y.

This formula may be deduced very simply in another way from the well-known theorem that, with both stresses and strains proportional to the corresponding distances from the neutral axis, the neutral axis must pass through the center of gravity of a homogeneous section. To bring our non-homogeneous section under this theorem, we must replace the steel by concrete, and also add enough concrete at the same distance from the top and bottom of the beam to take the excess of stress in steel, over that taken by the concrete in its place. (See fig. 2.) The unit stresses in the steel are $f_s^1 = e\frac{x-d_1^1}{x}f_c^1$ and $f_s = e\frac{y-d_1}{y}f_c$. The total stresses taken by the steel are $f_s^1A_s^1 = e\frac{x-d_1^1}{x}f_c^1A_s^1$ and $f_sA_s = e\frac{y-d_1}{y}f_cA_s$.

The unit stresses in the concrete at this same position are

$$\frac{x-d_1^1}{x}f_c^1 \text{ and } \frac{y-d_1}{y}f_c$$

So the stresses taken by the concrete replacing the area of the steel will be

$$\frac{x-d_1^1}{x}f_c^1A_s^1 \text{ and } \frac{y-d_1}{y}f_cA_s$$

Hence, denoting by A_c^1 and A_c the *additional* area of concrete in compression and tension, we have

$$A_c^1 = \frac{e\frac{x-d_1^1}{x}f_c^1A_s^1 - \frac{x-d_1^1}{x}f_c^1A_s^1}{\frac{x-d_1^1}{x}f_c^1} = \left(e-1\right)A_s^1$$

and $A_c = (e-1)A_s$. Taking moments about the bottom of the section, we have, for the position of the center of gravity of this area,

$$y = \frac{\frac{bh^2}{2} + \left(e-1\right)A_s^1\left(h-d_1^1\right) + \left(e-1\right)A_sd_1}{bh + (e-1)A_s^1 + (e-1)A_s}$$

or,

$$y \quad \frac{\frac{bh^2}{2} + \left[A_sd_1 + A_s^1\left(h^1-d_1^1\right)\right](e-1)}{A + (A_s + A_s^1)(e-1)}$$

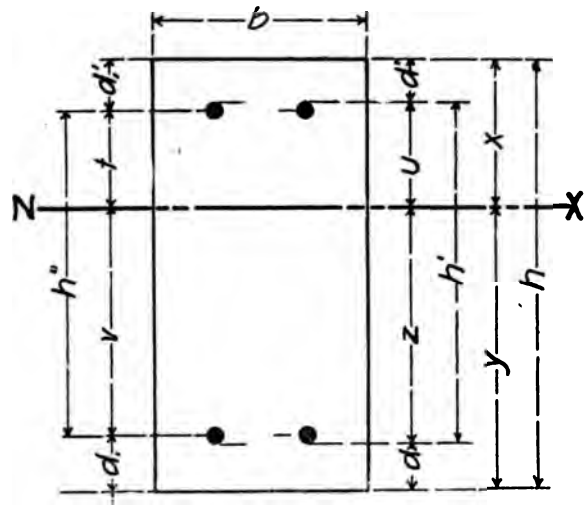

FIG. 1.

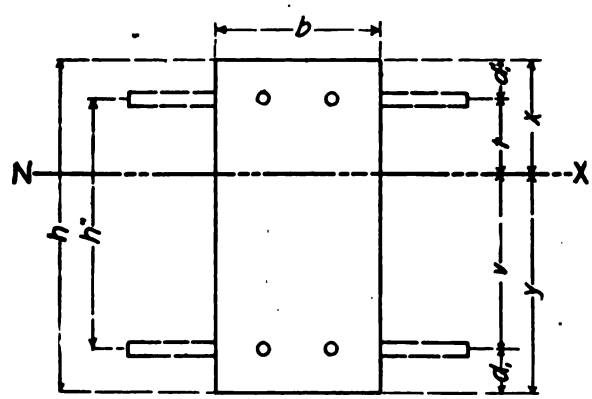

FIG. 2.

Comparing this with the author's formula (*1*), we notice that the terms d_1 and $h^1-d_1^1$ are raised to the second power, and that the sign of addition between the two main terms should be replaced by a sign of division. The latter is a mere misprint, as is evident from an illustrative example worked out on the succeeding page in the book. But the exponent is retained in this same example, showing that it is designed to be there. The numerical significance of the mistake may be shown by an example.

Consider a beam 4 inches wide and 16 inches deep. Let there be a rod 1 inch in diameter, so placed that its center is $1\frac{1}{2}$ inches

from the top of the beam, and a similar rod at the same distance from the bottom. Then $b=4$, $h=16$, $d_1=d_1^1=1\frac{1}{2}$, $A_s=A_s^1=.7854$ sq. in. Assume $E_s=29{,}000{,}000$ and $E_c=2{,}900{,}000$. Then $e=10$. Substituting these values in the author's formula (1), we have:

$$y=\frac{4\times\frac{16^2}{2}+\left[.7854(1.5)^2+.7854(14.5)^2\right]9}{64+(1.5708)9}$$

$=25.8$ inches. Substituting these same values in our new formula, we have

$$y=\frac{4+\frac{16^2}{2}+\left[.7854\times1.5+.7854\times14.5\right]9}{64+(1.5708)\times9}=8''$$

which is the correct result, since our beam was assumed symmetrical. Probably the reason that the author did not discover such an obvious mistake is because he assumed in his numérical example a beam having no reenforcement on the upper side. And it is in the square of the large term $h-d_1^1$ that the greatest error appears. Now, in the case of a built-in beam, reenforcement would be put in the top of the beam for at least part of its length.

The next formula that requires comment is formula (*8*)

$$I_c=\frac{bh^3}{12}-\left(A_sv^2+A_s^1t^2\right)$$

This should be $I_c=\frac{bh^3}{12}+bh\left(\frac{h}{2}-y\right)^2-\left(A_sv^2+A_s^1t^2\right)$

That is, in order to subtract one moment of inertia from another we must have them about the same axis. From the moment of inertia of the entire area about its center of gravity the author subtracts the moment of inertia of the steel about the neutral axis of the beam. This is correct only when these two coincide. And this is not generally the case. The extra term may or may not be a negligible quantity.

If we omit the rod in the upper part of the beam of our preceding example, we have $b=4''$, $h=16''$, $A_s=.7854$ sq. in.

$A_s^1=o$, $d_1=1\frac{1}{2}''$ and $e=10$.

$$y=\frac{\frac{4\times16^2}{2}+\left[.7854\times1.5\times9\right]}{64+.7854\times9}=7.37''$$

$$v=y-d_1=7.37-1.5=5.87''$$

whence, using the author's formula,

$$I_c = \frac{4 \times 16^3}{12} - .7854 \times (5.87)^2 = 1365 - 27 = 1338$$

$$\frac{h}{2} - y = 8 - 7.37 = .63''$$

Our added term is then $bh\left(\frac{h}{2} - y\right)^2 = 64 \times .63^2 = 25$, which shows that the missing term is, in certain cases at least, about as important as the second term of the formula given.

The next formula to which we direct attention is formula (*15*). We will apply the second method used in deducing formula (*1*). Now, however, we shall take moments about the top of the beam instead of the bottom.

A_c^1 = the area to be added to take the excess of stress in steel in compression $= (e-1)A_s^1$.

A_c = the area to be added to replace the steel in tension $= eA_s$.

$$eA_s + \left(h'' + d_1^1\right) + \left(e-1\right)A_s^1 d_1^1 + \frac{bx^2}{2} = x\left[eA_s + \left(e-1\right)A_s^1 + bx\right]$$

$$x^2 + \frac{2[eA_s + (e-1)A_s^1]x}{b} = \frac{2eA_s(h'' + d_1^1) + 2(e-1)A_s^1 d_1^1}{b}$$

whence

$$x = -\frac{e(A_s + A_s^1) - A_s^1}{b}$$

$$+\sqrt{\frac{[e(A_s + A_s^1) - A_s^1]^2}{b^2} + \frac{2e[A_s(h'' + d_1^1) + A_s^1 d_1^1] - 2A_s^1 d_1^1}{b}}$$

The difference here is not large unless A_s^1 is large. And generally if the concrete did not take tension, all the reenforcing would be on the lower or tensile side of the beam. But in formula (*1*) the author multiplies his areas by $(e-1)$; so, to be consistent, he should do the same here for the area in compression.

We have not discovered any further errors in this set of formulas. There is, however, an important error in their application to which we wish to call attention. The author uses this example:

"What is the safe bending moment for a reenforced concrete beam 16 inches deep, 4 inches wide, having one steel rod $\frac{7}{8}$ inch in diameter on the tensile side only, so placed that the center of

the rod is $1\frac{1}{2}$ inches above the bottom of the concrete? The resistance of concrete to tensile stresses is neglected. $f_c^1=700$, $E_c=3{,}600{,}000$, $E_s=29{,}000{,}000$."

Following is the author's solution of the problem:

"From equation (*18*) we have

$$x=-\frac{8.06}{4.0}\times 0.6+\sqrt{\frac{64.89\times 0.36}{16}+\frac{16.11}{4}0.6\times 14.5}$$
$$=-1.209+\sqrt{1.46+35.04}=4.833''$$

"From equation (*19*) we get

$$I_c=\frac{4\times 112.89}{3}=150.52$$

and from equation (*20*)

$$I_s=93.45\times 0.6=56.07.$$

"Since all the tensile stresses are carried by the steel, and all the compressive stresses by the concrete, and since the tensile stresses must balance the compressive stresses to fulfil the conditions of stability, we have $c=s=0.5$, and from equation (*14*) we obtain

$$M=\frac{150.52\times 700}{4.833\times 0.5}=43{,}601.9 \text{ inch-pounds."}$$

This solution is correct up to the words, "we have $c=s=0.5$."

This conclusion does not in general follow from the statement preceding it. It will follow when $v=\frac{2}{3}x$, and only then; for, if the stresses in tension and compression are equal, their lever arms must be equal in order to produce equal moments. The tensile stress is evidently applied at a distance of v from the neutral axis. The compressive stress increases from 0 at the neutral axis to f_c^1 at a distance x from the axis. So its point of application must be at a distance of $\frac{2}{3}x$ from the neutral axis. This condition does not obtain in this case.

Further, we should obtain the same moment from the use of equation (*11*) as from equation (*14*).

To use equation (*11*) we must compute f_s and z (=v approximately)

$$v = h - x - d_1 = 16 - 4.833 - 1.5 = 9.667''$$

$$f_s = e\frac{v}{x}f_c^1 = 8.06 \times \frac{9.667}{4.833} \times 700 = 11{,}284.$$

Substituting these values, and s=0.5 in formula (*11*) we have

$$M = \frac{56.07 \times 11284}{9.667 \times 0.5} = 130{,}875 \text{ inch-pounds.}$$

The correct solution is as follows:

From (*9*) $g = \frac{I_c}{eI_s} = \frac{150.52}{8.06 \times 56.07} = .333.$

From (*10*) $c = \frac{g}{1 \times g} = \frac{.333}{1.333} = 0.25$ and $s = \frac{1}{1.333} = 0.75.$

Substituting these values in (*14*) and (*11*), respectively, we get from (*14*): $M = \frac{150.52 \times 700}{4.833 \times .25} = 87{,}203.$

From (*11*), $\frac{56.07 \times 11284}{9.667 \times .75} = 87{,}250;$

which are the same, except for the slight difference due to decimals.

EXAMINATION OF COAL-DUST AFTER EXPLOSIONS IN MINES OF SOUTHEASTERN KANSAS.

By EDWARD BARTOW, University of Illinois, Urbana, Ill., read before the Academy December 1, 1905.

WHILE investigating the effects of coal-mine explosions in the mines of southeastern Kansas, in February, 1905, I collected two specimens of coal-dust showing the effect of the heat of the explosion. This coal-dust was on the sides of the timbers towards the explosion, and evidently had been carried through the air by the force of the explosion. The intense heat had apparently partially melted the particles of dust, causing them to stick together and to adhere to the supports and to the sides of the mines near the spot where the explosion originated. The coating of dust was at least one-quarter of an inch thick. In this paper are shown comparative analyses of this dust and of the coal collected from the respective mines, in an endeavor to show the effect of intense heat of the explosion on the coal.

Specimen of dust No. 1*a* was taken from the J. H. Bennett Coal Company's mine No. 1, two and one half-miles northwest of Weir City. In this mine an explosion occured January 26, 1905. Two shot-firers lost their lives and the interior of the mine and the shaft were considerably damaged.

Specimen of dust No. 2*a* was collected on February 24 from mine No. 1 of the Devlin & Miller Coal Company's mines, near Frontenac, six miles north of Pittsburg, Kan. In this mine two explosions occurred, on February 1 and 9, 1905, in which two shot-firers lost their lives. The interior workings of the mine were badly damaged, but, owing to the greater development, the explosion spent itself before reaching the shaft.

Specimen of coal No. 1 was collected from the J. H. Bennett Coal Company's mine No. 1 by Mr. James A. Orr, state mine inspector of Kansas. Specimen of coal No. 2 was taken by the writer from the Devlin & Miller Coal Company's mine No. 1, from the room in which the explosion of February 9 is supposed to have originated.

In the specimens of coal and dust thus obtained determinations of moisture, volatile and combustible matter, fixed carbon and ash are made according to the methods described in volume III of the University Geological Survey of Kansas, page 272.

For the sake of comparison of methods, we have added the results of a few analyses of Kansas coals from neighboring mines, made by Dr. W. R. Crane, and recorded on page 278 of volume III of the University Geological Survey of Kansas.

No.	Name.	Moisture.	Volatile and combustible.	Fixed carbon.	Ash.
1	J. H. Bennett Coal Company No. 1, coal	1.84%	40.55%	50.25%	7.36%
1a	J. H. Bennett Coal Company No. 1, dust	1.45	28.12	51.03	19.40
	Coal from neighboring mines, Weir City, Kan.:				
8	Kansas & Texas No. 18	3.57	36.96	51.84	7.63
9	Kansas & Texas No. 47	3.16	39.21	53.87	3.76
10	Durkee Coal Company No. 4	2.34	36.88	55.69	5.09
12	Hamilton & Braidwood No. 2	2.63	38.80	53.74	4.83
13	Central Coal Company No. 5	3.14	34.87	55.39	6.60
14	Durkee Coal Company No. 1	2.57	36.34	54.99	6.10
15	The Excelsior Coal Company	2.58	36.73	55.02	5.62
	Average of seven	2.857%	37.11%	54.70%	5.88%
2	Devlin & Miller mine No. 1, coal	1.79	39.13	53.41	5.67
2a	Devlin & Miller mine No. 1, dust	1.20	31.23	54.22	13.35
	Coal from a neighboring mine, Frontenac, Kan.	3.06	35.92	54.89	6.13

In the results of our examination we would call attention especially to the decrease in the volatile and combustible matter and the increase in fixed carbon and ash.

The dust after the explosion is probably mingled with dust from the roof and floor of the mine or it would be the best index of the amount of coal consumed by the explosion. In the one case the ash increased 2.35 times, and in the other 2.54. While this comparison is not accurate, it would indicate that a considerable proportion of the finely divided carbon was oxidized in the explosion.

The decrease in the volatile and combustible material is also interesting, and we would mention the fact that the finely divided coal is browner in color than the finely divided dust, and, also, when placed on white paper, leaves a much more decided streak. Experiments with regard to the action of air on the finely divided dust are being carried on.

THE FOUCAULT EXPERIMENT

[illegible]

[illegible] 22 feet long.

[illegible] Foucault's pendulum is involved in the law of [illegible] and it had occurred to others long before his time, but he was the first to bring it to a demonstration. The vibration is [illegible] always directed toward the center of the earth and is entirely independent of the motion of the point of suspension. The absolute motion of the pendulum in space is very complicated, and involves both the annual and diurnal rotations of the earth, but we are here concerned only with the relative motion in the direction of lines on the earth, and this is, as we shall see, at the pole fifteen degrees per hour. By considering the pendulum as a prolongation of the earth's axis, its plane of oscillation will cut across the meridians and will make a complete circuit in twenty-four hours.

At the north pole this apparent rotation would be like the hands of a clock, from left to right, while at the south pole this motion would appear in the contrary direction. At the equator there would be no rotation, while in other latitudes the motion would be the rate at the pole multiplied by the sine of the latitude. This may be shown in various ways by mathematical demonstration, and may be simply illustrated by the use of a globe, and drawing a line on the plane of oscillation and comparing its direction with

various meridians. The globe will show the apparent revolution of the plane of inertia, and the time will be twenty-four hours divided by sine of latitude.

The first attempt by the author of this paper to make an accurate Foucault pendulum was at Washburn College, some six or seven years ago, where one of the ventilating shafts in what is now called Rice hall was used, and where one could get a length of more than fifty feet, but the arc of vibration could be not more than one and one-half feet. The greatest difficulty was the narrow space for making adjustments, and yet some results were shown to this Academy which appeared to be of interest. The plan was adopted of marking the oscillations with a needle on a plate of smoked glass, and then blue-prints were made of these pendulum markings for the first time in experiments with the Foucault pendulum. One of these prints, made six or seven years ago, is still preserved.

In the state-house, near the Academy rooms, is a space which seems peculiarly well suited to the Foucault experiment. It is in one of the light shafts, and the Executive Council were ready to grant the use of this waste space for these experiments, provided no expense to the state was incurred. The light shaft in question is a space of about ten by fifteen feet, and extends from the first floor to the roof, where it is surmounted by a skylight resting on a system of iron trusses and rafters, and the rafters are covered with sheets of plate roofing glass.

The pendulum wire passes through a hole drilled through this glass, and then through a steel plate by a hole just large enough to admit a No. 15 piano wire. The wire is wound on an iron cylinder an inch in diameter, with a crank and a rachet wheel, furnished with a dog to hold it in any desired position. The length of this pendulum as determined by its rate of oscillation is about seventy-three feet, and the bob is a cylinder of lead terminating with a cone at the bottom, and weighs sixty-eight pounds. The lead is cast around a stout brass tube and is turned on a lathe to a symmetrical form. The brass tube coming through the lower extremity of the bob has inserted in it three concentric glass tubes, the inner one being just large enough to admit easily a No. 1 sewing needle. This smaller tube is narrowed by heating until it is able to let the point of the needle pass through one-fourth of an inch. It is now free to play up and down through this distance, and to trace on the smoked glass below the course of the pendulum through its circular arc. The time of a double oscillation is very close to three and one-half seconds. To start the pendulum, it is pulled to one

side by a small cord attached to a staple fixed as near as could be estimated to its center of oscillation. The thread is fastened to the wall and the bob, thus displaced, is left until it comes entirely to rest. Then the string is burned off and without any lateral push the pendulum falls, simply under the impulse of gravity. The smoked-glass plate rests on a platform, which has a mechanism for raising and lowering with parallel motion, and permits the tracing needle to follow the plate two or three feet or any other desired distance.

There are several disturbing agencies which prevent the pendulum from tracing a straight line as it swings, and make it move in an ellipse of greater or lesser eccentricity. The most troublesome of these is the action of air currents, which cannot be wholly avoided. Even if the room were tightly closed, the variations of temperature and movements of the observer would cause fluctuations of air which would sensibly affect the pendulum.

Another difficulty is the elasticity of the suspending wire. This is bought in coils and it is difficult so to straigthen it that it will not tend to fall in spiral twists which are not equally elastic in every direction. Then there is lack of perfect rigidity in the point of suspension, which must also fail to represent a true mathematical point. There is no better plan for suspension yet devised than the method described above, of allowing the wire to pass tightly through a hole in a metal plate.

The author once thought it important to provide a plan for rotation of the wire, but became convinced that this refinement was entirely useless. Aside from these mechanical imperfections there is another and an insurmountable object, which prevents the pendulum from swinging backward and forward in the same path. When the pendulum is drawn aside at its starting it must partake of the rotary motion of the earth, and this, combined with the gravitational force, is sure to give it an elliptical course. In securing the graphical representation of these vibrations, there is still another disturbing element, for our needle-point can seldom be brought into the true axis of the pendulum. Where this needle-point is not in the true axis its friction against the smoked glass tends to give the bob a rotary oscillation, and, in the experiments hitherto made, this rotary oscillation is quite in evidence. It gives the outside edge of our blue-print a curious wavy border, and the time of these oscillations is many fold greater than the regular swings of the pendulum. The impelling force is here the torsional elasticity of the wire, which, acting on the heavy weight, gives a

true harmonic motion, and the slowest hitherto observed by the author of this paper. It would require a pendulum many hundred feet long to secure this rate of vibration. There is still another oscillatory movement to be observed in our pendulum, and this is a vertical oscillation, an up-and-down movement, due to the longitudinal elasticity of the wire. This movement is much more frequent than the former and has no influence on the Foucault experiment.

It will be seen from inspection of the graphs that the minor axis of the elliptical oscillation is very small, not more than one-tenth of an inch in a swing of four feet, and the air currents are probably responsible for most of this. The time is so recent since the installation of the apparatus that but few experiments have as yet been made, but they encourage us to expect results as good as any hitherto obtained by other observers.

There is a thought, too, that this pendulum may record seismic motions, which will certainly be of interest.

The pendulum is where any visitor to the state-house can see it, and there is a certain impressiveness in the sweep of the heavy weight to and fro so steadily. When starting with long vibrations, and watched for some time, close observers will notice that the period of oscillation is sensibly shorter as the arc becomes less. The old Florentine, Galileo, was mistaken in thinking the swinging chandelier performed its vibrations in equal times, whether through long or short swings, but he was near enough right to instal the pendulum as our most perfect measurer of time. Starting with an arc of ten feet, this pendulum will continue to swing as much as fourteen hours when it does no work in tracing the smoked glass. After a few hours its path cuts across its first direction with an angle that shows the time of a complete rotation at this latitude to be more than forty hours. The cuts herewith given exhibit the deviation at different intervals, but experiment has not been made sufficiently as yet to secure accurate numerical results. These may be given in a future paper.

It was intended to exhibit the tracings of this pendulum by half-tone engravings taken from the smoked-glass blue-prints, but they will not do for making printing plates, and time has not been allowed for securing them in other ways. For the finest results these experiments must be made when the air is still, because the wind gives a tremulous motion to the state-house roof which disturbs the pendulum.

A DEEP WELL AT EMPORIA.

By Alva J. Smith.

THE well under consideration was drilled by Roberds & Lane for the city of Emporia, which had provided funds for the purpose by the issuance of development bonds. The well was begun soon after the first of the year 1904, the contract calling for a depth of 2000 feet, or to the Mississippian limestone. In the prosecution of the work the contractors were very unfortunate, having to abandon two wells at their own expense.

The first well was lost on account of the drill stem breaking, leaving the bit in the well at a depth of about 700 feet, where it was never recovered, although several weeks were spent in fishing for it. In the other well, which was drilled twelve feet south of the first one, a lug of iron was encountered. After drilling out large quantities of iron, the well was shot three different times, in the hope that the obstruction would be dislodged, but it continued to cut the rope, injure their tools, and impede the drilling, till the well was abandoned at a depth of 890 feet. In this well a stratum of coal of considerable thickness was encountered at a depth of 714 feet. As there was a probability of this coal being of commercial value, preparations were made for more accurately determining its thickness in the third well, which was drilled thirty feet south of the second one.

Eight or ten oil barrels were secured for the reception of all the drillings to be taken from the well while passing through or near the coal, and a contract was made with the drillers requiring them to remove their tools, bail out and measure up the well with a steel tape as often as the city might require.

The same formations were penetrated in this well as the other two, and the ten-inch casing put down to a depth of 690 feet, and no water was encountered for the next fifty feet.

When the hard sandstone above the coal was reached, the special gas committee of the city council and I were notified, and the work from that time till the coal was passed was under our personal supervision. When the drill penetrated a soft stratum beneath the sandstone they bailed out, and found they were drilling in slate. The depth of the well was then taken with a steel tape and the drillers instructed to drill one foot and then bail out, which they attempted to do, but the spring of the rope let the drill down

through the soft material four feet. On removing the drill it was found covered with coal and the water taken from the well was black. All the material removed by the bailer was saved and washed out. The drillings from this run proved to be one-fourth coal and three-fourths slate and bituminous shale. They then made a run of one foot all in coal. The next run was four inches in depth, and there was a trace of fire-clay on the point of the bit when removed, indicating that it had reached the bottom of the coal.

The next run of six inches was made in fire-clay, the drillings being about one-half coal, which was carried down from above, as the bailer is so constructed that it does not remove all the drillings, but leaves about a foot of them in the bottom each time, which would necessarily be mixed with the drillings of the succeeding run.

The thickness of the coal as thus shown was twenty-eight inches.

Another estimate of the thickness of the coal was made in the following manner:

From the 4-foot run	665	cubic inches of coal	was	saved.
" 1-foot run	960	"	"	"
" 4-inch run	288	"	"	"
" 6-inch run	265	"	"	"
Total.....	2,178			

Dividing the total number of cubic inches saved by 960, the number of cubic inches saved from the one-foot run in pure coal, we have 2.27 feet, or 27¼ inches, as the total thickness of the coal.

An analysis of the coal yielded the following quantities:

Water.....	7.96	per cent.
Volatile matter.....	33.13	"
Fixed carbon.....	39.64	"
Ash	17.27	"
Total.....	100.00	per cent.

The coal cokes readily and leaves a reddish-brown ash.

A sample was sent to Prof. E. H. S. Bailey, of the University of Kansas, and the following report was received from him:

"Moisture.....	7.91	per cent.
Volatile and combustible matter.....	35.38	"
Fixed carbon.....	38.08	"
Ash	18.63	"
Total.....	100.00	per cent.

"The coal leaves a red ash and cokes quite readily. By comparing it with other Kansas coals which are mentioned in volume III of the Kansas Geological Survey, it is evident that in some characteristics this coal is like the Osage; others like one sample of Lansing coal analyzed. The chief objection to the coal is the high percentage of ash. E. H. S. BAILEY."

A number of fine, sharp sands, resembling oil and gas sands, were found, but all contained salt water, instead of the hydrocarbons sought.

The figures in the column at the left of the accompanying well section are the numbers of the consecutive strata from the top downward; those in the first column to the right show the thickness of the strata, and those in the second column to the right give the depth in hundreds of feet from the top downward.

The well is located on lot No. 50 Congress street, in the city of Emporia, at a surface elevation of 1130 feet above sea-level.

Samples of the drillings were taken for the city by William Campbell and placed in their regular order in glass tubes, which are now on exhibition in the museum of the Kansas State Normal School.

Careful laboratory tests of the samples were made to see that they were properly named, and from the results I am convinced that the apparant discrepancies in the logs of wells from the same locality are largely due to the inaccurate naming of the samples, as well as lack of care on the part of the drillers to observe and report changes that occur in the formation.

On comparison with the samples taken from the Madison well* I find it quite easy to correlate a great many of them by their lithological character. The two sections agree very closely down to the bottom of the Iola limestone, where, instead of the ninety-nine feet of shale found at Madison, we have but seventeen feet at Emporia, which practically throws the Garnett, Iola and Erie or Bronson limestones into one great series of limestone beds extending from the Lawrence to the Pleasanton shales, a depth of 400 feet.

The Cherokee shales have a thickness of 356 feet, and the proportion of sand encountered is not greatly different from that in the Madison well.

Good samples of the Mississippian were secured which prove that that formation retains its flinty character westward at least as far as Emporia.

A careful comparison of the reliable logs and the samples from the various deep wells in Kansas would be an interesting study that I doubt not would result in valuable information in regard to the character, thickness and extent of the various formations, and perhaps throw some additional light on the geological history of our state.

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*See Trans. Kan. Acad. Sci., vol. XVI, p. 67.

Depth.	
3	feet.
25	"
30	"
32	"
36	"
39	"
53	"
60	"
72	"
85	"
94	"
98	"
140	"
145	"
161	"
163	"
173	"
175	"
190	"
237	"
264	"
264½	"
265	"
291	"
301	"
340	"
365	"
381	"
389	"
419	"
426	"
431	"
435	"
440	"
450	"
467	"
472	"
492	"
507	"
515	"
530	"
546	"
550	"
556	"
561	"
571	"
575	"
579	"
601	"
615	"
656	"
662	"
671	"
689½	"
690	"
709	"
712	"
714	"
715	"
735	"
800	"
805	"
820	"
833	"
842	"
906	"
944	"
950	"
968	"
985	"
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LOG OF A DEEP WELL AT EMPORIA, KAN.

No.	Strata.	Thickness.	Depth.
1	Soil	3 feet.	3 feet.
2	Clay, light	22 "	25 "
3	Gravel; fresh water	5 "	30 "
4	Limestone, blue	2 "	32 "
5	Shale	4 "	36 "
6	Limestone, blue	3 "	39 "
7	Shale	14 "	53 "
8	Limestone	7 "	60 "
9	Soapstone	12 "	72 "
10	Limestone	13 "	85 "
11	Limestone, red, shaly	9 "	94 "
12	Limestone	4 "	98 "
13	Shale, blue	42 "	140 "
14	Limestone	5 "	145 "
15	Shale	16 "	161 "
16	Limestone	2 "	163 "
17	Sand	10 "	173 "
18	Shale	2 "	175 "
19	Sand, micaceous	15 "	190 "
20	Sandy shale, brown	67 "	257 "
21	Limestone and black shale	7 "	264 "
22	Coal	½ "	264½ "
23	Fire-clay	½ "	265 "
24	Shale, sandy	26 "	291 "
25	Sandstone	10 "	301 "
26	Sandy shale; dark salt water	39 "	340 "
27	Limestone, green streaks	25 "	365 "
28	Shale	16 "	381 "
29	Limestone	8 "	389 "
30	Shale, brown	30 "	419 "
31	Limestone; dark fossils	7 "	426 "
32	Shale, black, bituminous	5 "	431 "
33	Limestone, white	4 "	435 "
34	Shale	5 "	440 "
35	Limestone; *Fusulina*	10 "	450 "
36	Shale, green	17 "	467 "
37	Limestone, fossils, red in places	5 "	472 "
38	Shale, dark steatite	20 "	492 "
39	Limestone, blue	15 "	507 "
40	Shale	8 "	515 "
41	Limestone	15 "	530 "
42	Shale, steatite	16 "	546 "
43	Limestone	4 "	550 "
44	Shale, calcareous	6 "	556 "
45	Sand	5 "	561 "
46	Shale, sandy	10 "	571 "
47	Limestone, fossiliferous	4 "	575 "
48	Shale, dark, calcareous	4 "	579 "
49	Sand	22 "	601 "
50	Shale, blue	14 "	615 "
51	Limestone, with calcite crystals	41 "	656 "
52	Shale, black	6 "	662 "
53	Limestone, soft, white	9 "	671 "
54	Shale, slaty	18½ "	689½ "
54½	Coal	½ "	690 "
55	Sand, hard	19 "	709 "
56	Shale, slate	3 "	712 "
57	Coal	2 "	714 "
58	Fire-clay	1 "	715 "
59	Sand	20 "	735 "
60	Shale, sandy	65 "	800 "
61	Limestone, blue	5 "	805 "
62	Shale, sandy	15 "	820 "
63	Sand, and dark brown, lime fossils	13 "	833 "
64	Shale	9 "	842 "
65	Sand	64 "	906 "
66	Sandy shale	38 "	944 "
67	Limestone, white, crystallized	6 "	950 "
68	Sand	18 "	968 "
69	Lime, white, soft, granular	17 "	985 "
70	Lime, white, hard, calcite crystals	8 "	993 "
71	Slate; salt water	5 "	998 "
72	Limestone	19 "	1,017 "
73	Shale, soapstone	6 "	1,023 "
74	Limestone, white	31 "	1,054 "
75	Shale, soapstone	10 "	1,064 "
76	Limestone; fossils, undetermined	40 "	1,104 "
77	Shale, argillaceous	3 "	1,107 "

LOG OF A DEEP WELL AT EMPORIA, KAN.—CONCLUDED.

No.	Strata.	Thickness.	Depth.
78	Limestone, white, crystallized	18 feet.	1,125 feet.
79	Limestone, bluish, hard	64 "	1,189 "
80	Limestone, white	19 "	1,208 "
81	Shale, slaty	17 "	1,225 "
82	Limestone, white	5 "	1,230 "
83	Shale, green streaks	8 "	1,238 "
84	Shale, red, hard	3 "	1,241 "
85	Shale brown	5 "	1,246 "
86	Limestone, fossils	16 "	1,262 "
87	Shale, black, slaty	3 "	1,265 "
88	Limestone, brown and white	45 "	1,310 "
89	Shale, black, bituminous	4 "	1,314 "
90	Limestone, pinkish oolite; salt water	35 "	1,349 "
91	Slate, black, bituminous	5 "	1,354 "
92	Limestone, hard	3 "	1,357 "
93	Shale	2 "	1,359 "
94	Lime	17 "	1,376 "
95	Shale	11 "	1,387 "
96	Sand	33 "	1,420 "
97	Shale, argillaceous	4 "	1,424 "
98	Sand	26 "	1,450 "
99	Shale, red	16 "	1,466 "
100	Shale, green streaks	22 "	1,488 "
101	Limestone, gray; fossils, flinty	16 "	1,504 "
102	Sand, gray	3 "	1,507 "
103	Shale, green	18 "	1,525 "
104	Lime, dark	11 "	1,536 "
105	Shale, black	4 "	1,540 "
106	Sandy shale	20 "	1,560 "
107	Limestone	15 "	1,575 "
108	Shale, slaty	4 "	1,579 "
109	Limestone, brown	16 "	1,595 "
110	Shale, black, bituminous	19 "	1,614 "
111	Shale, light	10 "	1,624 "
112	Shale, brown	3 "	1,627 "
113	Limestone, dark	5 "	1,632 "
114	Shale, slaty	12 "	1,644 "
115	Sand	26 "	1,670 "
116	Shale, brown	11 "	1,681 "
117	Sandy shale, dark	14 "	1,695 "
118	Shale, slaty	20 "	1,715 "
119	Shale, sandy, calcareous, hard	5 "	1,720 "
120	Shale, dark brown, sandy	33 "	1,753 "
121	Sand	5 "	1,758 "
122	Shale, black; bituminous coal	4 "	1,762 "
123	Sandy shale	7 "	1,769 "
124	Shale	16 "	1,785 "
125	Sand	5 "	1,790 "
126	Shale	15 "	1,805 "
127	Limestone, hard, dark	1 "	1,806 "
128	Shale	12 "	1,818 "
129	Limestone	3 "	1,821 "
130	Shale, black, slaty	6 "	1,827 "
131	Shale, dark gray, sandy	121 "	1,948 "
132	Shale, soapstone	3 "	1,951 "
133	Limestone, flinty, Mississippian	.....	.....

THE INTERPRETATION OF INDICATOR DIAGRAMS.

By CHARLES I. CORP, Lawrence.

THE important and essential knowledge to be derived from a careful investigation and study of indicator diagrams is invaluable to the engineer, as they enable him easily to ascertain and establish various facts concerning the use of steam that by any other method would prove complicated and unsatisfactory, of which the following may be stated:

First. It shows whether the valves of an engine are correctly and evenly timed, and also serves as a guide in all necessary adjustments of the same that may be required, in order to insure the best distribution of the steam working within the cylinder, and thereby securing the maximum economy and efficiency of the engine.

Second. The indicator power developed in the cylinder of an engine may be determined; also the quantity of energy lost in various ways; such as leakage of valves, back pressure, too early release, and incorrect adjustment of valves.

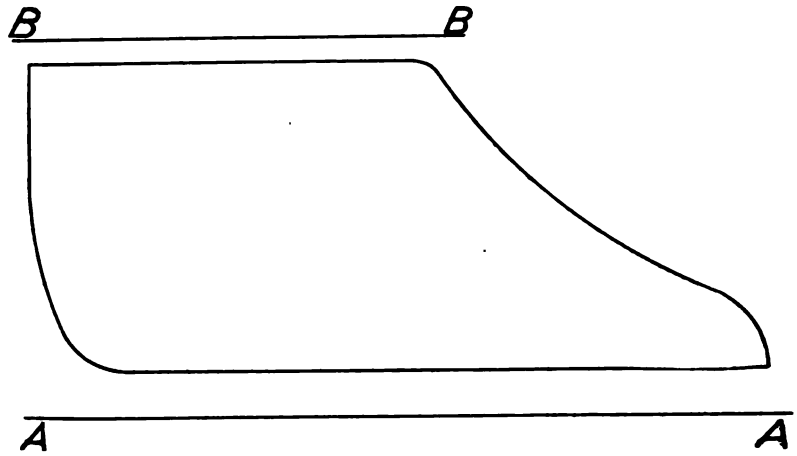
Third. It indicates whether the steam-ports and passages are adequate in size, and a diagram taken from the steam-chest will also show whether the steam-pipe and its connections are of sufficient size.

Fourth. It indicates the condition of the valves and piston in reference to the leakage.

Fifth. In connection with a feed-water test (showing the actual amount of steam consumed), the economy with which the engine works may be determined.

To ascertain with accuracy each and every item of information mentioned above, it is absolutely essential that the diagram should truly represent the position of the piston, and also the pressure exerted on both sides of it, at every point of its stroke.

The general features of a diagram that indicate a proper distribution of the steam in an engine cylinder is represented by diagram, the attainment of which (as near as possible) should be the endeavor of an engineer in setting the valves of his engine. AA is the atmospheric line and BB represents the boiler pressure.



In this diagram the initial steam pressnre, which is the highest pressure realized in the cylinder, is fully maintained up to the commencement of cut-off; indicating ample size of steam-pipes, ports and other passages in the engine.

The expansion curve is good, and the release of the steam is sufficiently early to secure a free exhaust, also low and uniform back pressure.

The exhaust valve closes on the return stroke, in time to provide the necessary compression (or cushion), and thereby counteracting in part the effects of inertia and momentum of the piston, cross-head, and other reciprocating parts, at the end of the stroke.

The admission of steam takes place promptly, and projects the admission line to initial pressure at right angles (or perpendicular) to the atmosphere line. These qualities in a diagram are an especial requisite under any circumstances, to insure an economical working engine.

In practice, however, there will be a great difference in the cut-line and appearance of the cards from the different engines, and even from the same engine, arising from numerous circumstances and conditions connected with it.

The diagram, as before stated, simply shows the pressure of steam existing in the cylinder at each part of the revolution of the engine, and it is the province of the engineer to determine whether these pressures at each and every point are the correct ones, and, if such is not the case, to ascertain wherein the fault lies that causes the error; then determine upon and apply the remedy.

It must be understood that, in a great majority of cases, the

shape or outline of the diagram depends principally upon the manner in which the steam is admitted to and released from the engine cylinder.

Therefore, by careful investigation and measurement of these outlines, and turning the varied information which they furnish to practical advantage, the real value of the indicator is readily made apparent.

As a preliminary to the study of the diagram, suppose we knew that, at a certain part of the stroke, the full boiler pressure should be realized; now, if this does not appear to be the case on the diagram, there is evidently imperfections existing, either from an incorrect adjustment of the valves, or maybe due to inadequate capacity of the steam-pipes and passages between the boiler and the engine cylinder; and almost invariably happens also with engines having insufficient or extremely light loads.

Again, the diagram may show too great a pressure at other certain points, when we know there should be less, in order that the demands for economy and efficiency in the engine be obtained. This latter circumstance may also proceed partly from incorrect valve adjustment, although it is principally caused by leakage through the admission valves after cut-off; in combination with the revaporation of steam previously condensed within the cylinder in the early part of the stroke.

Any derangement of valve mechanism of the engine, such as incorrect position of the eccentric on the shaft, or an uneven adjustment in the length of the valve-rods in connections, will in consequence be revealed in the diagram by late admission or release, by low initial or high back pressure, also by absence of compression; either of which, in performing an equal amount of work, will result in an increased consumption of steam.

Consequently, where discrepancies of any kind occur, a thorough investigation, study and reasoning of the diagram first become necessary, in order intelligently to locate the cause of the defect, and make changes and corrections accordingly, until the diagram shows a proper distribution of steam pressure throughout the stroke of the engine.

In this paper we shall deal only with the interpretation of irregularities in the lines of the card itself, and what these irregularities indicate.

An indicator diagram is the result of two movements which are at right angles to each other, one of which is the rotation of the paper drum forward and back around its central stud, and is pro-

duced on a reduced scale coincident with and by the movement of the engine cross-head, and thereby tracing a horizontal line on the paper drum at any time a contact is made between the drum and pencil. The other is the vertical movement of the pencil parallel to the axis of the drum, and is produced by the steam pressure acting on the piston of the indicator and forcing it to a height proportionate to the pressure upon the piston. Consequently, the length of the diagram represents the stroke of the engine on a reduced scale, while the vertical height at any point represents the pressure upon the indicator piston at a corresponding point in the stroke of the engine.

We will first study some distortions of the card from the ideal form due to faults of the indicator or its connections.

Should the reducing mechanism used not produce the exact piston motion reduced, or have lost motion in any of its parts, the card will not give a true record of what takes place. This might easily mislead one regarding what actually took place; so that it is essential our reducing mechanism be an accurate one and in good order.

If the steam passages from the cylinder to the indicator are not ample the card will be reduced in height, the initial pressures falling further than we would expect below the boiler pressure. A diagram taken from the steam-chest will usually locate this trouble.

Waves in a line of the card are caused by the inertia of the indicator parts when the pressure on its piston is suddenly changed. These waves become more marked as the speed of the engine increases, and at high speed cause the card to be much distorted. The distortion from this cause is also increased when the indicator spring used is too weak for the pressure. A spring should be used which will reduce this effect as much as possible without causing the card to be too low to indicate accurately engine faults.

The lines indicating rising or falling pressure will sometimes have steps in them. This is caused by the indicator mechanism sticking, usually by the piston becoming gummed up and sticking in its drum or cylinder.

A wave in a line of the card sometimes appears where we would not expect it from the indicator's inertia or other expected deforming forces, and this can usually be traced to the cord leading from the reducing mechanism rubbing or striking against some object.

The card from extremity to extremity should be as long as the atmospheric line, any difference in this respect showing unequal tension of the cord. Unequal pressure of the pencil against the

paper or stretching of the cord may cause this. The pencil should be well sharpened and held lightly against the drum, and fire wire substituted for long lengths of cord to remedy this. A good braided cord should be used, as they do not stretch as much as others.

The deviations of the cord from the perfect card explained so far have been due to faults in the mechanism for taking the card. We will now take up some departures that indicate faults in the engine itself, beginning with the admission line and going around the card in the order in which the events occur.

The admission line for a properly designed and regulated engine should start from a point one-third to two-thirds the distance up from the bottom or back-pressure line of the card and rise perpendicularly to nearly the boiler-pressure line. It is probably better with some types of engines if this line slopes out a little. Should the line slope too much outwardly, it indicates that this event is too early, and steam is therefore being admitted too much before the end of the stroke has been reached, and will be working against the steam in the other end of the cylinder. If the line, on the other hand, slopes inward from the perpendicular the valve is not opening soon enough, and the piston has started on its return stroke before the steam is admitted. If the admission line rises to the proper height and falls below a horizontal position before reaching cut-off, the passages leading from the boiler to the engine are insufficient at some point. Either the pipe-line or the engine-ports or steam passages do not admit enough steam. A diagram taken from the steam-chest will show whether the trouble lies in the steam line or the engine.

If in the steam line, the steam-chest pressure will drop as the piston travels outwardly on its stroke. At cut-off the line should round with a short bend into the expansion line; failure to do this shows too slow a closing of the valve at cut-off or a leaky valve. If a leaky valve is the cause, it can be told by the expansion curve.

In an unjacketed cylinder, we would expect the expansion line of the steam to be adiabatic. In the actual engine, however (jacketed usually with some non-contracting material), where the cylinder walls furnish some heat during the expansion and entrained and condensed water is evaporated during the latter part of expansion, the line is found to approach very near to the isothermal expansion curve. By drawing this curve in, then, we can determine whether the expansion took place as it should. An expansion curve which is too high shows that steam entered the cylinder after cut-off, and that the valve must leak. A leaky valve

will be less noticeable in the earlier part of expansion because the difference in pressure is slight, but will become more and more apparent on the expansion line as the pressure becomes more unbalanced in the latter part of the stroke. The presence of entrained moisture will also cause the terminal pressure to be high to some extent.

A leaky piston or exhaust valve, on the other hand, will give too low an expansion curve.

When release occurs too early the expansion line will drop suddenly before the end of the stroke is reached, to the back-pressure line, or very near it. Too late a release will cause the back pressure to be high at the beginning of the return stroke. A slow-opening exhaust valve will tend to slope the back-pressure line from release.

Cramped exhaust openings will raise the back-pressure line, which should not be at a height equal to more than two or three pounds above the atmospheric line. Compression should begin at a point that will bring the pressure in the cylinder up to one-third to two-thirds the distance to the top of the card when admission takes place. If less than this, the compression will not overcome the inertia of the reciprocating parts. If the line rises too high, compression takes place too early, and power is lost.

A BIT OF ENGINEERING AT MOUNT VERNON.

By M. L. WARD, Ottawa University.

THE mansion at Mount Vernon is about one-fourth of a mile from the Potomac river and about 150 feet above it. For about 400 yards from the river towards the mansion there is a wooded slope, crowned by a precipitous bluff from ten to fifteen feet in height. This bluff is about 100 yards from the mansion. This slope extending along the river is the deer park. In this park there have been many landslides, from time immemorial. Great masses of earth would become detached from the bank and slide down toward the river. This is shown by the uneven surface of the deer park. In 1903 occurred an immense landslide directly between the mansion and the river. Large masses of earth extending from the middle of the hillside even to the brow slipped down to the sea-wall which has been constructed to protect the bank from encroachments of the river. Repetitions of this slide would destroy a portion of the lawn and soon endanger the mansion. If possible they must be prevented. In May, 1903, the superintendent, Mr. H. H. Dodge, and the writer of this paper examined the locality, and we agreed that drainage only could solve the problem. Mr. J. A. Archer, a mining engineer, became interested in the matter, and I quote at length his account of work, which he kindly furnished me:

"An investigation of the serious condition at Mount Vernon, caused by landslides, was begun in May, 1903. These slides threatened the entire deer-park front, from the entrance gate to a point some 200 feet southwest of the old tomb, a total distance of about 800 feet. It was found that back from the Potomac river a distance of 300 feet, and 50 feet above the river level, a series of springs and marshy places occurred. One of these springs showed a daily flow of about 3000 gallons and another 2500 gallons. It was decided to make a series of borings to determine the general formation, with a view of establishing the levels of these different water veins. It was found that all the springs and 'weeps' came out on a bed of blue clay of twelve feet to fifteen feet in thickness, under which was another water-tight red clay of thirty feet in thickness; then five feet of sandstone to river level. Resting on this blue clay, fifty feet above river level, was a bed of water-bearing sand that showed varying thickness from five to fifteen feet. Through

this evidently the water came, and when this sand was washed out the clay bed over it was let down, and a landslide was the result. Knowing now the levels of this blue clay, and finding only a five-degree dip to southwest, an attempt to find the general course of the underground water was made, and with success. A ridge north of Mount Vernon, known as the horseshoe ridge, was examined, and found to consist of Columbia river gravel, in which abundant water was found. This ridge is about four miles north of Mount Vernon. Standing on this we could look over the entire country towards Mount Vernon. A very distinct ridge was seen ending at Mount Vernon, forming one side of the frog of a horse's hoof. From the contour of the remainder of the country within the horseshoe, it was plainly evident that the Mount Vernon water must follow under this ridge. Outlet springs on the line were found all along the proper level lines. It was determined to run a tunnel under Mount Vernon at right angles to the general course of this central ridge, to cut the underground streams as nearly at right angles as possible.

"It was thought that possibly three tunnels would be necessary, and provisions were made for this. It may be added that wells on the estate were examined and the general water-level taken in these. Five feet was the general water-level. Depth of wells, seventy feet. Work was commenced on tunnel No. 1. Two feet of blue clay was carried in the heading at the start in order to take up the depressions in the clay which we of course expected and that were due to water wear. Running in on a grade of two inches to 100 feet for the first fifty feet, we experienced no difficulty, except great care was required to avoid runs of lower quicksands and falling of loose sands from above. At fifty feet we ran suddenly against a very hard sandstone, cemented sand and iron, five feet in thickness, with a footing on blue-clay level of one foot of pure white quicksand. In this sand cement we found numerous roots, some partly decayed, and some only the form of roots with the wood all gone, leaving simply a limonite shell. This material was singularly hard to break, and great care had to be exercised to prevent runs of quicksand underneath. The latter was stopped by the use of sand-bags and fine lawn grass. Hay or straw was of no use. We had now crossed at right angles several streams and had a flow of about 2000 gallons of water per day. After getting through this difficult piece of ground we suddenly came into a bank of solid sand, filled with water to the depth of five feet, and capped with two feet of putty clay that was well-nigh past picking

or cutting out in any way. The water flow immediately picked up to 50,000 gallons per day, and held to this for a long period. We were draining out the entire basin under the hill, for such it proved to be. The springs commenced to fail, the wells to fall in their water-levels; the dam was broken.

"The putty clay in heading lasted for nearly 100 feet and was very hard to manáge, a special tool being made to cut it—a compromise between a mattock and the chisel point of a pick. Picks only went into it and drew out their width in clay. Mattocks could not be driven in deep enough to avail anything. After passing through this material a solid sand bed was encountered that required very careful handling to prevent its falling away from the putty clay, which had risen beyond the roof. This condition lasted to the end, a distance of 279 feet. Careful record had been kept of channels and slight depressions in the blue-clay level as the tunnel was driven. Each depression was marked in the timber sets. At the end we found a depression of four feet and six inches, and concluded that it was best to stop at this point. The drain had affected the old-tomb spring, one of our guides, reducing it by one-third; still with the clay depression at the end of the tunnel it seemed to be safer and cheaper (due to long haul) to cut No. 2 tunnel to isolate old tomb. It was necessary now to take up the depressions indicated in tunnel No. 1. A ditch with a grade of two inches to the 100 feet was started under tunnel No. 1, to take up the lowest depression, four feet six inches at its head. This tunnel had been timbered with a view to this. The timbers had been set four feet apart at the bottom and two feet at the top, so that a stringer could be run from No. 1 timber on the bottom to No. 3 on each side of the tunnel, and a jack placed across No. 2 timbers. This was tightened up and No. 2 mudsill taken out, thus swinging No. 2 so that the ditch could be cut out between these sets. This ditch was cut and the depression thus all taken up. The deepest depression had clay cores rammed down on the outflow side of the tunnel. This ditch was then filled, first with three inches of clear gravel from the size of a walnut to the size of a pea, thoroughly rammed. On this were laid three two-inch tile-drain pipes in pyramid form. The entire ditch was then filled in with the same gravel. The flow of water was 10,500 gallons per day. The springs and weeps as far as old tomb were practically dry. The well at the house, 150 feet distant from the tunnel, was dry. The greenhouse

well, 500 feet distant, was reduced by two feet. The old tomb spring was reduced one-third.

"Having now the exact conditions in the formation, and knowing the presence of the cemented dam around the hill, and its approximate width, we concluded to cut No. 2 tunnel to isolate the old tomb in blue clay, just carrying the sand level in the very top of the heading. The tunnel was driven in 125 feet. We encountered small streams of water as we went along, and broke through the limestone crust that lay between the blue clay and sand. Bore holes were made upward, so that we could feel our way across the iron dam. At 120 feet we commenced to get a good deal of water. All proper precautions were taken when we should break through under the dam. Sand-bags and grass were in readiness, and when, at 125 feet, we went into water-bearing sand, it was successfully held back and the water allowed to run out. The old-tomb spring stopped, and the tunnel was allowed to stand, except that a solid gravel filling was put in the heading in place of the grass and sand. This tunnel is to be filled with gravel, except near the mouth, where a cement wall, backed by a rammed blue-clay filling, is to be used as a dam, to back the water, to be carried off in pipes for further use. The water coming from the two tunnels is now concentrated into a cistern that had been constructed some years ago, and is forced into tanks by hydraulic rams, from which Mount Vernon gets its supply of water. The supply has been sufficient for all general use. The flow is 15,000 gallons per day now, from both tunnels. No diminution can be detected in the flow of the two tunnels. No sand is observed in catch-basins. Everything seems to come to rest.

"CONCLUSION.

"The problem is successfully solved. The whole hillside affected by the tunnels has dried out. No. 1 tunnel, left for observation, is to be filled with gravel, so that a channel will be left that will never close up. The theory regarding the dam formed around the brow of the hill may be of interest, and seems to have been borne out by facts. The iron in solution in the water was deposited probably in the form of pyrite by coming in contact with the tree roots. This was gradually changed to limonite. Old trees died out (last slide had two dead stumps of very old trees at its head), and gradually in wet seasons the water dissolved the iron, and a break in the dam occurred, and this caused a landslide.

"A quite interesting thing has been observed recently, pointing

out to us how the waters in the upper levels to the north and west of us get down from the Columbia river level, fifty feet above the first sand level, to the lower sand level. In making the railroad cut just north of Mount Vernon a fault in the Columbian blue-clay base is shown for over 100 feet in length. The blue clay shows a continuous line for a long distance, but quite suddenly a fault is disclosed, the clay capping over a sand bed for some twenty feet; then a clear sand bed occurs for eighty feet. This would, of course, allow the water on the upper level to go through. As a matter of fact, this river-bed is now dry, whereas four miles back it carries the water."

VII.

MISCELLANEOUS PAPERS.

"THE STUDY OF MINERALOGY FOR SELF-CULTURE."
By J. C. COOPER, Topeka.

"MUTATIONS AND THE EVOLUTION OF MAN."
By ALTON H. THOMPSON, Topeka.

THE STUDY OF MINERALOGY FOR SELF CULTURE.

By J. C. Cooper, Topeka.

THE opening lines of Bryant's poem "Thanatopsis" invite to the study of nature in these beautiful and impressive words:

> "To him who, in the love of Nature, holds
> Communion with her visible forms, she speaks
> A various language: for her gayer hours
> She has a voice of gladness, and a smile
> And eloquence of beauty; and she glides
> Into his darker musings with a mild
> And gentle sympathy, that steals away
> Their sharpness ere he is aware."

The purpose of the writer at this time is to say something additional, in a general way, to encourage the study of nature, and later on to call attention more particularly to the inviting field of mineralogy.

There is no more instructive, delightful and useful recreation for man than the study of some branch of natural science. As the young student becomes acquainted with nature's works, their beauty and usefulness and perfect conformity to law, they teach him the most useful lesson youth or manhood can learn, that throughout the wonderful and complicated machinery of nature's works there runs everywhere the binding thread of law and obedience, holding every atom of matter in wise and loving subjection to its will. And man, being composed of atoms of matter, must obey these laws, so far as they concern him individually, as positively as inert atoms, or he will inevitably suffer the consequences. A violation of nature's law cannot be condoned by the purchase of indulgence. It must be worked out with repentance.

All of us, when in a crowd, probably have been impressed with the variety of faces that pass before us. No two of them are alike, and it is quite probable that in the whole human family there are no two persons exactly alike. This gives us a little idea of the variety in nature. As these faces differ, we may reasonably assume that each individual will differ in his internal laboratory and his mental and spiritual wants. Yet, with all this difference, the field of nature is varied enough to furnish delightful, instructive and useful employment and recreation for all, if one gets into the line of work he is qualified and adapted for.

Emerson says: "The crowing fortune of a man is to be born to some pursuit which furnishes him employment and happiness, whether it be to make baskets, or broadswords, or canals, or statues, or songs."

One can conceive of the delight in a pursuit that furnishes employment and happiness. But through the incongruities of life, resulting from ignorance of and departure from law, very few are so fortunate as to enjoy that happy combination. The careful study of nature's works, constantly impressing us with the perfection and inviolability of her laws, will help us to approach that enviable condition.

The diversity of human wants is illustrated in the field of natural history study by the direction that the individual tastes and inclinations lead. Some develop a natural inclination for a particular field of study, and if they are rightly started in it they are among the fortunate few whom Emerson had in mind. The study becomes a love with them; a love that sweetens labor and duty.

The three broad fields of nature's works, animal, vegetable, and mineral, are subdivisible into numerous branches. A better acquaintance with any one subject discloses a wide field, again subdivided into specialties. Those who give the subject most thought and study, in any direction, find that greater excellence can be obtained by concentration upon a small field of work.

Application and industry educate the eye as well as the hand. The enthusiastic entomologist will catch the glint of a beetle's flight across his path when thousands of people would not see anything.

The writer, at one time, was showing some pretty minerals to a country friend who had his son with him, a stout boy of nineteen years of age. The boy asked, with astonishment, "Where did you get those things?" He was told that these had been picked up in rambles over the country, when he exclaimed, "I never see anything like them." And he did not—and comparatively few people do. Excellence acknowledges no guaranty but labor, and it takes the trained eye to catch the flight of a beetle, or the form of a fossil, or a crystal in the rock. Even the hues of the earth and the blue of the sky have no beauty for some people. The eyes might transfer to their soul the granduer of what they could take in in a sweep, but they don't. In fact, we might almost believe we were daily among men who

> "Could strip, for all the prospect yields
> To them, their verdure from the fields;
> And take the radiance from the clouds
> With which the sun his setting shrouds."

Mineralogy more intimately concerns the human family than any other branch of natural science. All the elements that enter into the composition of matter are mineral. Our bodies, the earth we live on, the air we breathe, the water we drink, the food we eat, all the articles of use that minister to our necessities and comforts, all the articles of ornament that adorn the homes of luxury, all the colors of paint upon the artist's palette, the bloom on beauty's cheek, and the flowers—"those reminisences of Eden and prophecies of heaven—the splendid children of the sun and the jewelry of the soil," are all made up of and are resolvable into mineral elements.

Nature invites to this study by adorning the material with the beauties of all the gems. She fashions from the most common materials her most beautiful and precious gems. From carbon, an abundant and common mineral, which, as coal and charcoal, contributes so much to our necessities and comforts, by an art that man has not yet been able to imitate profitably, she fashions the diamond.

From the abundant element, aluminum, which makes up, probably, one-tenth of the entire earth, combined with oxygen, another common element which makes up about one-half of the earth, she makes the sapphire, the oriental or true ruby, the oriental emerald, the oriental topaz, and the oriental amethyst. These, when found perfectly crystallized, and composed of pure oxide of aluminum, with a little coloring matter from some mineral oxide, are among the most valuable gems known. The pure aluminum ruby, when of perfect color, is more valuable than the diamond. Nearly all the favorite gems, next in degree of value to the diamond, and the pure oxide of aluminum, are varying oxides of aluminum, silicon, and iron, with occasional oxides of a few other metals.

It is exceedingly interesting to study this feature of nature's work—how she makes her most beautiful gems out of the most abundant and common mineral. Like, in our republican form of government, where the human elements have free opportunity to develop, we bring forth our Lincolns, Garfields, Grants, and nearly all the leading minds in commerce, in the industries, in art and literature, from the common material of society. There is hardly a distinguished man in this country to-day who has not, in this, or only a few generations back, come up from the common people.

The sentiment of mineralogy is abundant and beautiful; but it will be more interesting to practical minds that are anxiously concerned about their daily needs to consider, more particularly, the practical uses to which this study can be applied.

There seems to be a wise forethought and lawful purpose in all of nature's work. She has crystallized all the common and many of the rare minerals into beautiful forms and adorned them with attractive colors, and many of them with a luster of finish that rivals the lapidary's art, evidently to attract our attention and get us interested in them. An acquaintance with their beauties of form and color naturally leads us to want to know something of their composition and useful properties, and this want invites to the study of the chemistry of mineralogy, which opens up more of the useful secrets of nature's work, for man's necessities, health, and comfort, than any other department of natural science.

The field of the practical uses to which mineral atoms can be applied is so broad, it so intimately concerns all our material wants, that it furnishes infinite employment for human pursuit. The mining and fabrication into useful and ornamental forms and compositions of all the metals—of gold, silver, iron, aluminum, zinc, lead—the varieties of useful rocks, the alkalies and clays, give employment to the most varied talents. A little reflection will impress the student with the useful fields this study opens.

All the elements made known by chemistry are found in minerals, for the mineral kingdom is the source of whatever living beings—plants and animals—contain or use.

"The chemist cannot make anything; he only supplies the favorable conditions for the action of the laws that absolutely govern every atom of matter."

Having shown that mineralogy deals with all the elements that make up this earth and all that there is on it, and, in all probability, all matter of every kind throughout space, its usefulness cannot be questioned.

The writer has been surprised at the lack of interest manifested in this particular department of natural science in our collegiate institutions. Fossil geology, or paleontology, seems most to interest them. Perhaps they have become so accustomed to devote study to dead languages and dead things that they do not appreciate the vitality of the living present and the prospective activity of the coming future.

The writer's attention was particularly attracted recently, upon the receipt of a circular from the University of Chicago, to a list of professors under the head of "department of geology." This list enumerated seven different subdivisions of this department, with a special professor at the head of each. These subdivisions were: "Head professor of geology," "professor of geographic geology,"

"professor of petrology," "professor of economic geology," "professor of pre-Cambrian geology," "professor of paleontological geology," and "professor of archeologic geology," but not a single professor of mineralogy.

Some time ago when in Chicago, the writer visited that great institution, which already has cost many millions of dollars, and inquired for their mineral collection, and was informed that they did not have any. It was suggested that such an institution should have a good collection of minerals to assist in their educational work. They gave as the reason for not having any minerals that they did not have money to spend for them, although they were about to invest a good many thousands of dollars for some bones of gigantic fossil animals of the Carboniferous period which had been discovered in Utah.

I felt a good deal like saying that we were not living in the Carboniferous age now, and that something pertaining to the present day and its practical work might prove a great deal more useful.

Mineralogy is preeminently a practical science. It is in direct contact and intimately associated with the activities of to-day. It holds in its wide domain more of interest to the future of humanity than any other branch of natural science.

Microscopic mineralogy is a very pleasing and attractive branch of the study. Nature has, in a measure, concealed many of the most exquisite beauties of her work in such minute forms that it requires the most powerful microscope to develop their beauties. One great advantage of this branch of the study is in the small space required for a collection. Many have been deterred from collecting minerals because the material is so bulky, and requires a great deal of space to exhibit it to advantage. This objection is done away with in microscopic mineralogy. The writer has a friend and correspondent in Philadelphia, a gentleman of wealth and excellent taste, who devotes his whole attention to microscopic work. It is a great pleasure to look over his collection, which pretty well covers the field of amateur mineralogical study. It was contained in a few small cabinets, or boxes of drawers, each about one foot square, which could be picked up like a satchel and carried about anywhere. He had a small room which he called his "den," about twelve feet square, a round table about three feet in diameter, the top of which revolved freely. We sat on one side of this table, with my friend opposite. He would take out one of his mounted specimens, which did not occupy more than a square inch of space,

and, placing it under the large binocular microscope and adjusting the focus, would turn the top of the table around so that the microscope with its object would come in front of myself for observation. In that little room we spent a delightful evening looking at the beauties of the mineral kingdom, exhibiting the most perfect crystallization, and gorgeously beautiful in color. Crystals so minute that they could not be seen by the naked eye appeared under the microscope as large as sections of a lead-pencil. It was a great pleasure to discover that quite a number of his most beautiful and rare gems were some that the writer had picked up on old dump piles in New Mexico and Arizona and had sent to him.

The microscope discloses the fact that a great deal of nature's most perfect and beautiful work in the mineral kingdom is in minute forms. Large minerals require the natural and best light of day to bring out their beauties, but these little gems under the microscope can be seen to advantage and studied by artificial light.

Something should be said to encourage the youth—the boys and girls—to become interested in this study. It does not cost much to get a few interesting specimens of minerals for them and some rudimentary works on minerals. A little later a microscope will open a new world of beauties to them. Then the determination of them will give them endless employment and happiness. It will bring them only good, and keep them from a great deal that might be harmful. It is healthful, physically and morally, instructive and entertaining.

It makes a very attractive and interesting study and recreation for women. There is nothing so attractive to an esthetic taste as the gems of the mineral kingdom. One cannot conceive of a more delightful recreation for a cultured woman than to gather these gems and study their varied forms and beauties. By gems is not meant, what a good many would suppose, the costly gems, but the gems of the mineral kingdom—small, unique and good crystallizations of the minerals. The gathering of these is not confined to the minerals that are found in the neighborhood. They can be obtained at moderately reasonable prices from houses that deal in minerals and by exchange with collectors in other localities. When a collector finds himself or herself in possession of a number of duplicates of any mineral, by the possession of a copy of the Naturalists' Directory, a book that is published giving the name and address of all known collectors, with their specialties, he can select persons to correspond with who are interested in the same line of work, and learning what his correspondents have to ex-

change, he can work up a profitable and pleasant exchange, thereby getting acquainted with many pleasant correspondents, and adding to his knowledge of minerals and to the enlargement and variety of his own collection.

To the aged and those pretty well advanced in life, who have given some study to this subject, the collection of minerals furnishes an endless and interesting source of recreation and instruction. When disappointments and cares oppress them their minerals will always meet them with a friendly countenance and an amiable disposition. They are always teaching something, and they do it so kindly and so thoroughly that they prove most agreeable companions.

No matter how one may feel depressed by human ingratitude and want of sympathy, when one turns to his minerals for companionship and friendly counsel they will not be a source of disappointment. They will disperse the demons of despondency and unrest, and open up fields of study in God's works that so beautifully illustrate the perfect laws of wisdom and love with which the Great Master rules His universe, so that hatred, sadness and disappointments will leave the mind, and a cheerful spirit will take their place and give renewed courage and hope.

The field of this inviting study is illimitable, and the worlds to conquer are always waiting for industrious and enthusiastic effort.

MUTATIONS AND THE EVOLUTION OF MAN.

By ALTON H. THOMPSON, Topeka.

THE discovery and demonstration of the principle of mutations in the formation of species and varieties of plants, by Hugo De Vries, is one of the most brilliant achievements in the history of evolution since the publication of Darwin's "Origin of Species." Its recent promulgation has thrown a flood of light upon many puzzling and obscure questions, and has aided materially in the solution of some intricate problems in the science of biology. Of course, there is danger of carrying it too far in its application, like all revolutionary discoveries, for after all it only supplements natural selection and assists in solving problems that that great principle could not account for. It is a source of wonder to later scientists that Darwin, with all his observations and great insight into the workings of nature, should have failed to perceive the idea of sudden mutations, and held it as an inviolable principle that all changes of structure were due to very gradual alterations, the result of natural selection.

Darwin succinctly states his doctrine in a letter to Haeckel, as follows: "Having reflected much on the facts, it seems to me probable that allied species were descended from a common ancestor. But during several years I could not conceive how each form could have been modified so as to become so admirably adapted to its place in nature. I began, therefore, to study domesticated animals and plants, and after a time perceived that man's power of selecting and breeding from certain individuals was the most powerful of all means in the production of new races. Having attended to the habits of animals and their relations to surrounding conditions, I was able to realize the severe struggle for existence to which all organisms are subjected; and my geological observations had allowed me to appreciate the duration of past geological periods. With my mind thus prepared, I fortunately happened upon Malthus's 'Essay on Population,' and the idea of natural selection through the struggle for existence at once occurred to me."

So it remained for the astute mind of De Vries to perceive that sudden changes of structure were possible, and under certain conditions could be made permanent. The general acceptance and the revolutionary effect of the idea of the origin of species by mutations has been marvelous, and is second only to the revolutionary

wave that swept over the world of thought following the publication of the "Origin of Species."

Hugo De Vries says of the previous condition of the science of origins (in speaking of Burbank's work) that, "Of great scientific importance is the question whether repeated selections are sufficient to bring about new forms, and, further, if by this means more variations are produced. We have no facts to indicate this, but it has great importance in the study of conditions. It is closely connected with the question whether species slowly merge into one another or whether they originate by mutations. In the former case small deviations would increase in the course of generations, and thus a long series of intermediate forms would connect man and all other species. In the latter case of mutations a jump is made without any intermediate stages."

The doctrine of mutations is founded upon seven laws, which De Vries thus states: "(1) New elementary species appear suddenly, without intermediate steps; (2) they spring latterly from the main stem, not affecting it; (3) they attain their full constancy at once; (4) some of the new strains are elementary species, others are to be regarded as varieties; (5) the same new species are produced in a large number of individuals; (6) mutations undergo fluctuating variation, but the latter is not evolution; and (7) mutations take place in nearly all directions."

Like Darwin, his great discovery was founded on experimentation, elaborate and long continued, and he worked upon well-known and familiar facts. Stock-breeders and horticulturists have long employed the method of making permanent the sudden changes that produce variations, but no one before ever attempted to formulate the facts of mutation into a law and to conduct investigations upon such a basis.

Prof. Chas. A. White thus well summarizes the subject in *Science:* "Species originate from other species through the ordinary function of reproduction, but they each originate suddenly and completely by one mutative act, and not by the slow accumulative variations of individuals. The beginning of the mutative process which is due to some unknown natural determinative cause, some molecular change in the germ-cell of the fertilized ovum, whereby the new individual acquires changed structural characters. The new species thus produced by mutation is in immediate possession of clearly distinguishing and hereditarily transmissible characters, and it has no more tendency to hybridize with any other member of the mother species than have other species. Strains

thus produced are called elementary species, and differ distinctly but not widely from the mother species."

It is well known that geologists have long been dissatisfied with the theory of natural selection by the accumulation of slow progressive changes as the one method of the origin of species.

Professor White again says: "There has been an increasing distrust of the theory of natural selection for the origin of species that Darwin proposed a half-century ago, and it has been especially felt in endeavoring to apply it to certain lines of paleontological investigation. It has been regarded with growing disfavor in such cases, as it is shown that genera, families, orders and classes of animal and plants have, during geological time, usually originated with such comparative rapidity as to make it necessary to infer that species have originated suddenly; that the ratio of progressive development has not only not been uniform, but has been exeedingly diverse; that environment had little to do with the origin or destruction of species. These and other items made it necessary to presuppose some other theory for the sudden origin of species to harmonize them with the past conditions which they reveal. After the fishes and reptiles, a sudden change marks the introduction of the placental mammals which occurred about the beginning of Tertiary time. These highly organized animals assumed faunal dominion of the earth which the decadent dinosaurs had just departed from. They came in great diversity of forms, and their organization was little if any inferior to that of the mammals now living of lower grade than the Quadrumana. There has been found no evidence of evolution from earlier forms by any slow process, and they became extinct at or before the close of the Eocene epoch. They were succeeded by the Miocene and Pliocene mammalia, exhibiting many strange and suddenly introduced forms. Indeed, the history of the mammalia from the earliest Tertiary to the present time embraces a record of rapid and varied evolution of the highest grades of animals, culminating in man. If it should ever be possible to trace the evolution of man from the lower animals, it will probably be found that it has been accomplished, not by the slow process of natural selection, but by a series of sudden mutations."

Indeed, the theory accounts for much in the evolutionary history of man that has been lacking. In the first place, his geological history is quite insufficient to allow of his gradual development, according to the theory of natural selection, by slow accretions of alterations. The earliest form of lemur, *Anaptomorphus*, which was probably the ancestor of all of the Anthropoidæ, is too recent

to allow time enough, geologically, for the slow evolution of man from this stock. We have reason to believe that the psychic emergence of man from lower forms was a sudden mutation, and from the start his mental evolution took place by leaps and bounds. All of his physical alterations and his special brain and mental development indicate such a process of sudden mutations. To be sure, the gap between man and the highest anthropoids has been materially lessened by the discovery of *Pitheconthropus* and the studies of the pygmies, but there are still many missing links which were necessary according to the theory of natural selection. With the principle of mutations, however, we can dispense with these links in the formerly supposed necessary chain, and observe how perfectly the wonderful theory of mutations can account for perhaps all of the marvelous changes that have taken place in the evolution of man.

The theory of mutations will alone account for the psychic emergence in relation to its necessary suddenness and the successive rapid changes that took place in the growth of the brain in response to higher mental activity and the correlative changes in physical structure. The theory of selective influences and the slow accretion of alterations has never been satisfactory, and has bitter opponents. The early geological horizons in which stone implements of supposedly human manufacture have been found, the authenticity of which has never been satisfactory, need not trouble the anthropologist now, for it is possible that man could have emerged as suddenly as many other animals which the geological history of the earth has demonstrated. The problem of man's origin is now in a fair way of being solved and fills us with excited expectation. We can accept with confidence now the evidence of his existence in early geological formations, which we have felt heretofore that we must reject as impossible. The geological evidences of the earliest occurrence of man, are now trustworthy, and we can accept them without the reluctance with which we have heretofore regarded them. We can now believe in the possibility of Pliocene man, and the disputed questions of the probability of early Pleistocene man are at once settled. All the implements of early man can now be accepted as genuine, and perhaps a flint chip from the Miocene even, which we have held as being impossible of human workmanship, we may now regard as possible.

Not only does early geological man thus become a certainty through the theory of mutations, but it will also throw much light upon later and other anthropological problems; for instance, the

question of the origin of races, which has always been a most difficult one. That the great variations of mankind could have arisen merely through the influence of environment, climate, food, terrestrial or cosmic influences, which were tentatively offered, owing to the theory of slow changes, we have been long convinced are not sufficient. We now feel satisfied that the great racial variations originated suddenly, by mutations, and that from "sports," so to speak, the races had their origin. The mutation theory throws a flood of light upon this great question, but which awaits the working out of the details.

The theory accounts also for the origin of very early civilizations, which we have heretofore believed must have had a slow growth by natural development. We can now realize how a superior race could spring into prominence, and, by unusual ability, rapidly evolve a high civilization; as witness the ancient Assyrians, Egyptians, Greeks, Romans, Peruvians, Mexicans, and others. History tells us that the rise and development of such peoples were very rapid, and that a very few centuries were required for them to progress from savagery to high civilization, and which we now know must have been due to mutations—to the sudden appearance of superior intellects without a previous gradual development. Modern nations also have arisen into intellectual prominence and accomplishments by leaps and bounds, as many examples that occur at once to every one will amply prove. At the present time we need some moral mutations to correct the aberrations of conscience of men in high places.

Indeed, the idea opens up an illimitable field for speculation. As a recent writer in *Science* well said: "Born in the womb of lower animals, man has become the most wonderful living thing on earth, although separated now by a great gulf from his next of kin. Inexperienced in his early history, his mind steadily advanced, until to-day he contemplates all nature with a yearning to know its mysteries. The changes in the germ-cell sufficing to evolve him are as inscrutable to his reason as the constitution of matter or the interstellar space ether, or the origin, nature and the meaning of life itself. But we ardently desire to know these things—to peer out into unfathomable space and to speculate upon the meaning of our existence and the unknowable as we perceive it all about us in the universe. But as a species, *sapiens*, of the genus *Homo*, we can never know. We seem to be but intellectual atoms floating in an infinity of space and time."

VIII.

ANNOUNCEMENTS, ETC.

ANNOUNCEMENT.

IT HAS long been the desire of many of our members to secure the annual publication of our Transactions, but not until this year has it been possible. By assurances that the total expense to the state would not be increased beyond the sum heretofore granted, we were able to secure assent of the printing committee, and now issue volume XX, part I. The volumes will be numbered biennially, as heretofore, and the larger part of the edition will be in paper covers, which facilitates their distribution in foreign countries, and does not lessen the value for exchanges. If our next meeting be held in Thanksgiving week, and the papers presented are promptly handed in, it will be possible to get them into the printer's hands before the rush of legislative printing occurs, to delay their publication.

We have secured the reprinting of our four lacking volumes—IV, V, VI, and VII, and now can supply missing numbers or complete sets to any of our members at very moderate expense. In accordance with the usage of other societies, it is likely that a liberal discount will be made to members from our list prices, although these are not high.

The secretary would like expression from the members as to choice of time and place for next meeting, that these preferences may be laid before the executive committee of the Academy.

J. T. LOVEWELL, *Secretary.*

TOPEKA, March 9, 1906.

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1869-'73.... F. H. Snow.
1873-'75.... R. J. Brown.
1876, '77.... W. K. Kedzie.
1878-'83.... R. J. Brown.
1884, '85.... A. H. Thompson.
1886-'90.... L. D. Graham.
1891..... F. O. Marvin.
1892-'95.... D. S. Kelly.
1896..... L. E. Sayre.
1897-1900... J. W. Beede.
1901, '02.... E. C. Franklin.
1903-'06.... Alva J. Smith.

MEMBERSHIP OF THE ACADEMY,

January 1, 1907.

Dates in the following list signify date of election to membership in the Academy.

HONORARY MEMBERS.

G. P. Grimsley, Ph. D., 1904, asst. state geologist... Morgantown, W. Va.
Rev. Johns D. Parker, Ph. D., 1897..... New Haven, Conn.
Arnold B. Johnson, 1897, U. S. Lighthouse Board.... Washington, D. C.
W. A. Kellerman, Ph. D., 1897, Ohio State Univ..... Columbus, Ohio.
Edw. L. Nichols, Ph. D., 1897, Cornell Univ..... Ithaca, N. Y.
W. S. Franklin, Sc. D., 1897, Lehigh Univ..... South Bethlehem, Pa.
Geo. Wagner, Phar. D., 1904, Univ. of Wisconsin.... Madison, Wis.
S. W. Williston, Ph. D., 1902, Univ. of Chicago..... Chicago, Ill.

ASSOCIATE MEMBERS.

Mrs. R. J. Brown, 1903..... Leavenworth.
Mrs. Mary Savage, 1897..... ..... Lawrence.

LIFE MEMBERS.

E. H. S. Bailey, Ph. D., 1883, Univ. of Kansas..... Lawrence.
J. C. Cooper, 1877, mineralogist..... Topeka.
F. W. Cragin, Ph. D., 1880..... Colorado Springs.
L. L. Dyche, M. S., 1881, Univ. of Kansas..... Lawrence.
Geo. H. Failyer, Ph. D., 1879, Dept. of Agr..... Washington, D. C.
E. C. Franklin, Ph. D., 1884, Stanford Univ..... Stanford Univ., Cal.
I. D. Graham, 1879, with *Kansas Farmer*..... Topeka.
Erasmus Haworth, Ph. D., 1882, Univ. of Kansas.... Lawrence.
Warren Knaus, M. S., 1884, editor..... McPherson.
D. E. Lantz, M. S., 1887, Biological Surv..... Washington, D. C.
J. T. Lovewell, Ph. D., 1878..... Topeka.
F. O. Marvin, C. E., 1884, Univ. of Kansas..... Lawrence.
J. R. Mead, 1879..... Wichita.
Ephraim Miller, Ph. D., 1873, Univ. of Kansas..... Lawrence.
E. A. Popenoe, A. M., 1872, Kansas Agr. Coll..... Manhattan.
L. E. Sayre, Ph. M., 1885, Univ. of Kansas..... Lawrence.
Alva J. Smith, 1903, county surveyor..... Emporia.
B. B. Smyth, 1880, curator Goss ornith. coll..... Topeka.
F. H. Snow, Ph. D., 1868, Univ. of Kansas..... Lawrence.
A. H. Thompson, D. D. S., 1873..... Topeka.
M. L. Ward, D. D., 1880, Ottawa Univ..... Ottawa.
J. T. Willard, M. S., 1883, Kansas Agr. Coll..... Manhattan.
S. W. Williston, Ph. D., 1880, Univ. of Chicago..... Chicago, Ill.

ANNUAL MEMBERS.

L. O. Adams, 1903, Univ. of Kansas..... Lawrence.
Orr Adams, 1898..... Tulluride, Colo.
Frank G. Agrelius, 1905..... Lawrence.
Wm. Aitkinhead, 1906, Washburn Coll..... Topeka.
H. C. Allen, 1904..... McPherson.
Carroll D. Armstrong, M. D., 1905..... Salina.
John J. Arthur, 1904..... Topeka.
C. H. Ashton, 1903, Univ. of Kansas..... Lawrence.
Alfred W. Ayers, 1904, minister..... Onaga.
W. M. Bailey, 1906, teacher..... Holton.
Harvey W. Baker, 1902, Kansas Agr. Coll..... Manhattan.
Elam Bartholemew, M. S., 1905..... Stockton.
Edward Bartow, Ph. D., 1897, State Water Surv..... Urbana, Ill.
W. J. Baumgartner, M. D., 1904, Univ. of Kansas... Lawrence.
Frank G. Bedell, 1904..... Iola.
J. W. Beede, Ph. D., 1894, Univ. of Indiana..... Bloomington, Ind.
F. W. Bushong, B. S., Univ. of Kansas..... Lawrence.
H. P. Cady, 1904, Univ. of Kansas..... Lawrence.
M. E. Canty, 1903..... Buffalo.
Charles I. Corp, 1905, Univ. of Kansas..... Lawrence.
Ewing N. Collett, 1903, Indian Univ..... Bacone, I. T.
Rev. John T. Copley, 1903..... Clinton.
R. W. Coppedge, 1905, teacher high school..... Topeka.
E. G. Corwine, 1905..... Mulvane.
W. R. Crane, 1904, Univ. of Kansas..... Lawrence.
Ralph K. Crawford, 1904, Univ. of Kansas..... Lawrence.
F. F. Crevecœur, 1899..... Onaga.
Robert W. Curtis, Ph. D., 1902, Univ. of Kansas.... Lawrence.
F. B. Dains, Ph. D., 1902, Washburn Coll..... Topeka.
Emil O. Deere, 1905, Bethany Coll..... Lindsborg.
S. D. Dice, 1904..... Alma.
James Dickson, 1904, Univ. of Kansas..... Lawrence.
Robert K. Duncan, 1906, Univ. of Kansas..... Lawrence.
R. B. Dunlevy, B. S., 1896, Southwest Kan. Coll..... Winfield.
E. X. H. Dunmire, 1905, Univ. of Kansas..... Lawrence.
Harry Eagle, 1905..... Topeka.
H. W. Emerson, 1904, Univ. of Kansas..... Lawrence.
B. F. Eyer, B. S., 1894, Kansas Agr. Coll..... Manhattan.
T. L. Eyerly, 1906..... Canadian, Tex.
W. F. Faragher, 1904, Univ. of Kansas..... Lawrence.
Thomas B. Ford, 1905, Univ. of Kansas..... Lawrence.
Lillian E. Fowler, 1905, teacher high school..... Ottawa.
A. O. Garrett, 1901, teacher high school..... Salt Lake City, Utah.
Frank Gephart, 1906, Univ. of Kansas..... Lawrence.
Brice E. Hammers, 1904, chemist..... Topeka.
Dr. Eva Harding, 1904..... Topeka.
H. J. Harnly, B. S., 1903, McPherson Coll..... McPherson.
W. A. Harshbarger, B. S., 1900, Washburn Coll..... Topeka.
Frank Hartman, 1905..... Kansas City, Kan.

ANNUAL MEMBERS.

L. D. Havenhill, 1904, Univ. of Kansas..... ..... Lawrence.
Dr. Francis C. Herr, 1905 ..... Ottawa.
W. C. Hoad, 1904, Univ. of Kansas..... Lawrence.
Gertrude E. Hole, 1906..... Manhattan.
George J. Hood, 1904, Univ. of Kansas..... Lawrence.
H. A. Horton, 1906..... McPherson.
W. F. Hoyt, A. M., 1902, Wesleyan Univ..... Salina.
L. C. Hodson, 1905, Univ. of Kansas ..... Lawrence.
B. C. Hubbell, 1905..... Concordia.
Albert K. Hubbard, 1904, Univ. of Kansas..... Lawrence.
Thomas M. Iden, 1897, State Norm. Sch ..... Emporia.
F. B. Isely, B. S., 1902, teacher high school ..... Wichita.
John J. Jewett, 1902..... Sawtelle, Cal.
A. W. Jones, B. S., 1894, Wesleyan Univ..... Salina.
George F. Kay, 1904, Univ. of Kansas..... Lawrence.
W. H. Keller, 1898, teacher high school..... Effingham.
Leslie A. Kenoyer, 1906 ..... Independence.
Harry L. Kent, 1904, State Norm. Sch..... Hays.
John H. Klopfer, 1904..... Topeka.
Pierce Larkin, 1902, high school ..... Helena, Okla.
B. E. Lewis, 1904, teacher city schools ..... Eureka.
M. A. Low, 1906, attorney..... Topeka.
C. H. Lyon, 1900, teacher high school..... Emporia.
Hester E. Loveall, 1904, manual tr. sch..... Kansas City, Mo.
H. T. Martin, 1902, Univ. of Kansas..... Lawrence.
R. Matthews, D. D. S., 1898..... Wichita.
C. E. McClung, 1903, Univ. of Kansas..... Lawrence.
D. F. McFarland, 1903, Univ. of Kansas..... Lawrence.
J. M. McWharf, M. D., 1902 ..... Ottawa.
W. G. Medcraft, 1904, Wesleyan Univ..... Salina.
Grace R. Meeker, 1899 ..... Ottawa.
C. F. Menninger, M. D., 1903..... Topeka.
H. L. Miller, 1904, high school..... Topeka.
W. L. Moodie, 1906, Univ. of Kansas..... Lawrence.
Travis Morse, 1903 ..... Iola.
J. H. Newby, 1899 ..... Osage City.
N. P. Nielsen, 1906, architect..... Topeka.
A. M. Nissen, A. M., 1888, teacher high school ..... Wetmore.
Henry N. Olson, 1905, Bethany Coll..... Lindsborg.
Frank Patrick, 1903..... Topeka.
Leslie F. Paull, 1903, manual tr. sch..... Kansas City, Mo.
L. M. Peace, 1904, Univ. of Kansas ..... Lawrence.
Arthur D. Pitcher, 1906, Univ. of Kansas ..... Lawrence.
Norman Plass, D. D., 1902, president Washburn Coll.. Topeka.
M. A. Pond, 1906, teacher..... Topeka.
L. M. Powell, M. D., 1906 ..... Topeka.
Charles H. Popenoe, 1903, Kansas Agr. Coll. ..... Manhattan.
C. S. Prosser, M. S., 1892, Ohio State Univ..... Columbus, Ohio.
W. S. Prout, 1904 ..... Topeka.

ANNUAL MEMBERS.

Albert B. Reagan, 1904, Indian School..... Mora, Wash.
W. F. Rice, 1902..... Gordon.
W. B. Robertson, 1905, Univ. of Kansas..... Lawrence.
A. P. Ruediger, 1905..... Lawrence.
W. G. Russell, 1905..... Russell.
D. C. Schaffner, 1903, Coll. of Emporia..... Emporia.
J. H. Schaffner, A. M., M. S., 1902, Univ. of Ohio.... Columbus, Ohio.
Theo. H. Scheffer, 1903..... Emporia.
Eva Schley, 1903, teacher high school..... Topeka.
Aaron Schuyler, 1904, Wesleyan Univ..... Salina.
C. H. Shattuck, 1899, Washburn Coll..... Topeka.
Roscoe H. Shaw, 1904, Univ. of Missouri..... Columbia, Mo.
Miriam Sheldon, 1906, Bethany Coll..... Topeka.
E. T. Shelley, M. D., 1902..... Atchison.
Claude J. Shirk, 1905, McPherson Coll..... McPherson.
J. A. G. Shirk, 1904, Ottawa Univ..... Ottawa.
Paul L. Shuey, 1905, Univ. of Kansas..... Lawrence.
Ralph C. Shuey, 1905, Univ. of Kansas..... Lawrence.
Eugene G. Smyth, 1901, Univ. of Chicago..... Chicago, Ill.
Mrs. Lumina R. Smyth, M. S., 1902..... Topeka.
W. N. Speckman, Ph. D., 1903, Wesleyan Univ. ..... Salina.
William O. Starin, 1906, Univ. of Kansas..... Lawrence.
B. T. Stauber, D. D., 1903..... Salina.
S. G. Stewart, M. D., 1904..... Topeka.
Chas. M. Sterling, 1904, Univ. of Kansas..... Lawrence.
Chas. H. Sternberg, 1895, explorer and collector..... Lawrence.
Teresa Stevenson, 1901..... Ottawa.
E. F. Stimpson, 1904, Univ. of Kansas..... Lawrence.
A. J. Stout, 1904, teacher high school..... Topeka.
Frank Strong, Ph. D., 1905, chancellor Kansas Univ., Lawrence.
Olin Templin, 1904, Univ. of Kansas..... Lawrence.
F. J. Titt, B. S., 1898, Kingfisher Coll..... Kingfisher, Okla.
E. S. Tucker, 1904, Univ. of Kansas..... Lawrence.
J. D. Walters, M. S., 1894, Kansas Agr. Coll..... Manhattan.
C. D. Weaver, M. D., 1902..... McPherson.
Ella Weeks, 1903, Kansas Agr. Coll..... Manhattan.
J. E. Welin, 1899, Bethany Coll..... Lindsborg.
Archie J. Werth, 1906, Univ. of Kansas..... Lawrence.
C. H. Withington, 1903, Kansas Agr. Coll..... Manhattan.
H. I. Woods, M. S., 1902, Washburn Coll..... Topeka.
L. C. Wooster, Ph. D., 1897, State Norm. Sch..... Emporia.
J. A. Yates, M. S., 1897, Ottawa Univ..... Ottawa.

Total number of members, January 1, 1907, 173.

MINUTES.

Thirty-ninth Annual Meeting, Kansas Academy of Science, November 29, 30, and December 1, 1906.

TOPEKA, KAN., November 29, 1906.

BY appointment of the executive committee, the Kansas Academy of Science met at its rooms, and was opened at eight P. M., with the president, F. O. Marvin, in the chair. About twenty-five members were present. By adjustment of the museum tables it was found that this room gave ample space for the meeting and was altogether convenient and commodious.

TREASURER'S REPORT.

Reports of officers being called for, the treasurer presented the following:

ACCOUNT OF THE TREASURER OF THE KANSAS ACADEMY OF SCIENCE TO NOVEMBER 29, 1906.

Receipts.

Balance on hand from last year	$488 23
Fees and dues	132 70
Sale of Transactions	12 99
Total	$633 83

Expenditures.

December 14, 1905.	To typewriting programs	$1 25
February 6, 1906.	Reprinting volume IV	78 20
March 20, 1906.	Illustrations	5 50
March 20, "	Subscription, *Journal of Geology*	3 50
March 20, "	Express	1 00
March 20, "	Reprinting volume V	88 55
April 18, "	Reprinting volume VI	108 10
July 20, "	Reprinting volume VII	157 00
December 3, 1905.	Placed on time deposit	250 00
Total		$693 10

November 29, 1906, balance due treasurer, $59.27.

On motion, this report was referred to W. A. Harshbarger, as auditor, and found correct. Approved.

SECRETARY'S REPORT.

The secretary is pleased to chronicle another year of progress for the Academy. We are now fairly entered on the era of annual volumes of our Transactions, and our colleagues will have the encouragement of publishing at an early date whatever contributions they may make to scientific discovery. We can do this because it is of mutual convenience to the state printer and to the Academy, and no one will object so long as this plan does not increase the expense to the state. A certain annual appropriation is now admitted as reasonable, and with the growth of the state and its institutions, the Academy may expect to share recognition according to its merit. It is of course expected that in biennial years the legislative printing will take the precedence in the state printing-office, and in order to have early publication in such years, our Transactions must be in hands of the printer before the legislative rush begins. Past experience shows that delays are most likely to come from neglect of members to get their papers ready for the press; and to secure the results now aimed at, the papers ought after being read at the annual meeting, to be placed at once in the hands of the secretary for publication. The time may come when our Transactions will be issued as quarterly bulletins and so save a considerable item of expense on their distribution by mail. Following the custom of past years, the secretary issued an announcement in the summer of the coming annual meeting, and this is sent to all members and to others who may be stimulated to joining in our work.

THE MUSEUM.

Care of the museum is part of the secretary's duty. The ability and good fortune of my predecessor, Doctor Grimsley, enabled him to lay the foundation of a very useful economic museum for our state. This must be enlarged and improved till we can show the forms and distribution of our mineral wealth. As this museum had its inception in the St. Louis Exposition, so the coming Kansas semicentenial ought to bring it to perfection. It will be for the Academy to guide in this development, and there is no way in which we may expect more cordial cooperation or in which we may be more useful to the state. This is one of the ways in which we may show ourselves worthy of being a "coordinate branch of the State Board of Agriculture."

THE LIBRARY.

The growth of our library is an illustration of the comity and universality of science. In this realm there are no state lines, no political divisions. Our fellow workers, whether in Australia, St. Petersburg, or Peru, are ready to share with us in their discussions and to rejoice in our discoveries. So from the beginning of our history we have found other scientific bodies, all over the world, ready to exchange with us their publications, even when our members were few and our Transactions only filled a small pamphlet. In these exchanges we have been conscious of getting the better end of the trade, and our older sister societies have shown their sympathy in being willing to accept our productions and wait for us to grow to something better. We have grown, and our late volumes make a respectable showing as compared with others of their class. Reprints of the first seven volumes enable us to exchange complete sets of the first twenty volumes, and we can, with some assurance, offer these for the valuable works coming to us from other societies.

ACCESSIONS.

During the past year we have received not less than 500 unbound volumes, pamphlets, and parts of volumes, which are filed away and await the time for binding. Several hundred volumes are now in a greater or lesser state of completeness, and in some cases missing numbers will be difficult to secure. Some of them may be purchased, but it will require much correspondence, and will be impossible always to get complete *sets*, though we may have complete volumes.

Over fifty bound volumes have come to us during the year, the larger portion of these being from the Smithsonian, and other government departments in Washington. Many of these are of great value, bulky, finely illustrated, and would be a valuable acquisition for any library.

Our library has a good many volumes in foreign languages, which will interest only a small number of our members, but it is important to have one collection in the state where these foreign books may be consulted.

In government publications like those of the Smithsonian, of the Geological Survey, and of the Agricultural Department, our files are duplicated, both in the State Library and in the State Historical Society. The latter has the most complete collection found in our state-house of these books.

CATALOGUING.

The usefulness of a library depends largely on a convenient catalogue. In the Transactions, from volume X *et seq.*, much space has been given to the librarian's reports, wherein catalogues and lists of accessions to the library have been published. The library contains a card catalogue, where the volumes are grouped by countries and by titles. From our Transactions, volumes XIV to XVIII, inclusive, in the librarian's reports, may be found a record which gives substantially the contents of our library. There is also an authors' card catalogue and a subject card catalogue, on which considerable time has been spent. To complete these according to modern library standards, with cross-references, etc., will require much labor as well as skill. Before undertaking any very complete system of cataloguing, it may be well to consider our connection with other libraries and book collections in the state-house, and see whether a common union and management of these is not feasible. Needless duplication of books could be avoided, expense of binding saved, and, more important than all, a single and complete catalogue might be kept where it could be found, if any desired volume was available anywhere in the state-house.

PURCHASE OF NEW BOOKS.

Funds available for buying new books have been applied this year to reprinting volumes IV to VII of our Transactions. Money will be further needed to secure missing numbers in the volumes of exchanges above alluded to, and it is desirable to have our material bound as early as possible. From membership fees and dues a small income is assured which may be applied to the library and to other Academy work.

After report of the treasurer and secretary, President Marvin named the following committees:

On nominations: Willard, Wooster, and Cady.

On resolutions: Knaus, Bailey, and Yates.

On program: Sayre and Harshbarger.

On necrology: Thompson, Sternberg, and McWharf.

On publication: The retiring president, the secretary, and one member from Topeka—in this instance, Professor Dains.

On membership: Cooper, Harshbarger, and Miss Meeker.

On time and place for next meeting: Welin, Shattuck, and Smith.

There being time, on motion the Academy next listened to a paper by Prof. L. E. Sayre, numbered 2 on the program, entitled, "Drug Standards with Reference to the Pure Food and Drug Law."

The meeting adjourned to meet to-morrow morning at nine o'clock.

ACADEMY ROOMS, Friday, nine A. M.

President Marvin announced the committee on library, as follows: Professors Shattuck, Kay, and Wilm.

The committee on membership reported the following applications to become members of the Academy:

Wm. Leslie Moodie, laboratory assistant in biology, Kansas University, Lawrence.

Robert Kennedy Duncan, professor of industrial chemistry, Kansas University, Lawrence.

Archie J. Werth, assistant chemist State Water Survey, Lawrence.

Arthur D. Pitcher, instructor mathematics, Kansas University, Lawrence.

E. C. Wilm, teacher in Washburn College, Topeka.

Wm. Aitkinhead, teacher in Washburn College, Topeka.

Frank Gephart, fellow in chemistry, Kansas University, Lawrence.

Wm. O. Starin, fellow in biology, Kansas University, Lawrence.

Leslie A. Kenoyer, student, Independence.

M. A. Low, general attorney Chicago, Rock Island & Pacific railway, Topeka.

T. L. Eyerly, science teacher, Canadian, Tex.

L. M. Powell, M. D., physician and surgeon, Topeka.

Gertrude E. Hole, teacher, Manhattan.

M. A. Pond, teacher of penmanship, Topeka.

Miriam Sheldon, teacher of science, College of the Sisters of Bethany, Topeka.

W. M. Bailey, teacher natural science, Holton.

H. A. Horton, student in botany, McPherson.

On motion, it was voted that the rules be suspended, and the secretary was instructed to cast the ballot of the Academy for the persons named in this report. The ballot was duly cast, and they were accepted as members of the Academy on complying with the condition of fees and enrolment.

The Academy divided into sections and resumed the reading of papers, as announced on the published program.

SECTION A.

B. F. Eyer, chairman; J. A. Yates, secretary.

No. 1. Dances of the Jemez Pueblo Indians (by title), Albert B. Reagan.

No. 3. Modulus of lunar influence—not in lifting but in falling movement (by title), J. J. Jewett.

No. 4. A most wonderful tool, John H. Klopfer.

No. 5. Harmonic forms—plane forms (second paper), B. B. Smyth.

No. 6. The form and dimensions of the earth, H. I. Woods.

No. 7. On the composition of Kansas oil, F. W. Bushong.

No. 8. The quantitative estimation of iron and cobalt by the rotating cathode, R. W. Curtis and S. A. McReynolds.

No. 9. On the formation of azo compounds, F. B. Dains.

No. 10. On the precipitation of potassium ferrocyanide in the presence of ammonium salts, F. B. Dains.

No. 11. Method of analysis for pharmaceutical preparations (by title), L. D. Havenhill.

No. 12. Method for the detection of small quantities of benzine in gases (by title), W. F. Faragher.

No. 13. The pharmaceutical industry of America (by title), H. W. Emerson.

No. 17. Short methods for drug assay (by title), H.W. Emerson.

No. 49. A test for artificial bleaching of flour (by title), J. T. Willard.

No. 51. The capacity of a condenser as a function of time, as found by the method of direct discharge as well as by alternating currents (by title), Bruce V. Hill.

No. 37. Nature photography in Kansas—the work of Mr. and Miss McColm, Grace R. Meeker.

Voted that the privileges of the floor be extended to all visitors.

Adjourned, to meet in general session in the manual training high school hall, at two o'clock P. M.

SECTION B.

J. E. Welin, chairman; W. A. Harshbarger, secretary.

The section met in the library of the Academy, and the following program was presented:

No. 18. Some geological studies on northwestern Washington, and adjacent British territory (by title), Albert B. Reagan.

No. 19. Development of forest belts in the northwestern part of of Clay county, Kansas (by title), John H. Schaffner.

No. 20. An adequate cause for extremes of climate in geological periods (by title), J. J. Jewett.

No. 21. Records of desultory collecting in Kansas and Colorado (by title), E. S. Tucker.

No. 22. Contributions towards a catalogue of insects in Kansas (by title), E. S. Tucker.

No. 23. Corrections and additions to the list of Kansas mammals (by title), D. E. Lantz.

No. 24. Remarks on the bird fauna of Kansas (by title), D. E. Lantz.

No. 25. Catalogue and key of the Kansas flora (by title), Bernard B. and Lumina Riddle Smyth, and John H. Schaffner.

No. 26. Food habits of our Kansas lizards and batrachians (by title), F. A. Hartman.

No. 27. A list of hymenoptera collected in Arizona in 1902, 1903, 1904, 1905 and 1906 by the Kansas entomological expeditions, F. H. Snow.

No. 28. Recent additions to the bird fauna of Kansas, F. H. Snow.

No. 29. Soil bacteria (by title), L. C. Wooster.

No. 45. Additions to the list of Kansas coleoptera for 1906, W. Knaus.

No. 46. Sacramento mountains, New Mexico, coleoptera, W. Knaus.

No. 47. Notes on Kansas coleoptera, W. Knaus.

No. 48. Kansas Carabidæ, Cerambycidæ, and Chrysomelidæ, W. Knaus.

Many of these papers were read by title and others by abstracts, so that not much time was consumed, and session was adjourned to meet with section A.

GENERAL SESSION, FRIDAY, NOVEMBER 30.

MANUAL TRAINING HALL, two P. M.

No. 30. Preliminary announcement of a serial catalogue of periodicals, transactions, etc., found in the Academy of Science, Washburn College and state libraries, F. B. Dains.

No. 31. Some tests of Kansas road metals, F. O. Marvin.

No. 32. Kansas climatology, T. B. Jennings.

No. 33. The spectrum and spectrum scales, J. T. Lovewell.

No. 34. Is the Gila monster (*Heloderma suspecta* Cope) a venomous reptile? F. H. Snow.

No. 35. Heredity in stock-breeding, I. D. Graham.

No. 36. Nomenclature of the Kansas Coal Measures (by title), E. Haworth and J. Bennett.

No. 38. The composition of ice-cream, Frank Gephart and E. H. S. Bailey.

No. 39. Some animals I have discovered in the fossil beds of Kansas, Charles H. Sternberg.

No. 40. Some results of the entomological expedition to Arizona in June and July, 1906, F. H. Snow.

No. 41. Coffee—analysis of different qualities, L. E. Sayre.

No. 50. Noise—its relation to health, disease, and longevity, J. M. McWharf.

No. 52. The measurement and comparison of sound intensities (by title), Bruce V. Hill.

Presidential address, recent movements in engineering, F. O. Marvin.

At the close of this address it was voted to hold the next general session at nine A. M. December 1, at Washburn observatory. The session adjourned for a banquet tendered by the local members at the Y. W. C. A. rooms.

BANQUET.

For many years it has been customary for the members to break bread together at least once during the annual session, and these occasions help to knit closer our comradeship. The tables on this occasion were made cheery with floral decorations, and a neat menu, interspersed with appropriate and suggestive quotations, gave piquancy to the nicely served viands.

Dr. A. H. Thompson acted as toastmaster, and in the post-prandial program gracefully introduced the speakers who had been chosen to enliven the feast and enable members for the moment to unbend from serious work. A poem by Mrs. Joseph Savage, one of our earliest members, was read, and received with cordial applause.

J. C. Cooper gave the address of welcome on behalf of the local committee, and the following gentlemen responded to toasts with great acceptance: F. O. Marvin, B. F. Eyer, J. E. Welin, L. E. Sayre, J. I. McWharf, Warren Knaus, F. H. Snow, and B. B. Smyth.

GENERAL SESSION, DECEMBER 1, 1906.

WASHBURN OBSERVATORY, nine A. M.

The committee on place and time of meeting reported as follows:

That the annual meeting of the Academy for 1907 be held in the city of Emporia; the time is to be left in the hands of the executive committee.

J. E. WELIN,
C. H. SHATTUCK,
ALVA J. SMITH,
Committee.

Report approved. The committee on nomination of officers reported their nomination for—

President, J. A. Yates, Ottawa.
Vice-president, E. Haworth, Lawrence.
Vice-president, F. B. Dains, Topeka.
Secretary, J. T. Lovewell, Topeka.
Treasurer, A. J. Smith, Emporia.

On motion, the rules were suspended, and J. C. Cooper cast the ballot of the Academy for the candidates named by the committee for officers and they were declared duly elected.

On motion, J. C. Cooper was granted life membership, on complying with conditions relating to dues, if there be any in his case.

It was voted that back volumes of the Transactions be furnished to members at one-half the published list price.

Voted that the committee on publication be instructed to publish "separates" or reprints, when these are desired by authors of papers, provided that the financial end of the proposition be made satisfactory.

Reading of papers was continued, as follows:

No. 44. Structure and classification of wood found in the moraines of Jackson county, C. H. Shattuck.

No. 43. Some notes on the origin of heterospory, as shown in cultures of *Marsilea* (illustrated by the reflectoscope), C. H. Shattuck.

No. 42. The accuracy of a modern balance and set of weights, H. I. Woods and Alice K. McFarland.

On motion, the secretary was instructed to send greetings and programs to J. R. Mead, L. C. Wooster, and Mrs. Joseph Savage.

RESOLUTIONS.

The committee on resolutions reported:

Resolved, That the thanks of the Academy of Science are due the local members of the Academy and their friends, for the agreeable banquet and reception so generously tendered.

Resolved, That we appreciate the favor shown us by the papers of Topeka, in their report of our daily proceedings, and thank them for their courtesy.

Resolved, That we thank the faculty of Washburn College and the Topeka board of education, for the facilities afforded us in holding our meetings.

W. KNAUS,
E. H. S. BAILEY,
J. A. YATES,
Committee.

On motion, the Academy adjourned *sine die.*

HISTORICAL SKETCH.

THE organization of a Kansas association of scientific men at an early date was due to the efforts of Rev. Johns D. Parker and Prof. B. F. Mudge, who, in July, 1868, issued a call signed by seventeen men for a meeting of all persons in the state interested in natural sciences to meet in Topeka.

The first meeting was held in September of that year, in Lincoln College (now Washburn), and the Kansas Natural History Society was organized and officers elected. The object, as stated in the original draft of the constitution, "shall be to increase and diffuse a knowledge of the natural sciences, particularly in relation to the state of Kansas." At the fourth annual meeting, held in Leavenworth, in 1871, the name was changed to the Kansas Academy of Science. In 1873 the Academy became a coordinate department of the State Board of Agriculture by the terms of the following act of the legislature:

"The Academy of Science shall be a coordinate department of the State Board of Agriculture, with their office in the agricultural rooms, where they shall place and keep for public inspection the geological, botanical and other specimens, the same to be under the direction and control of the officers of the said Academy of Science. An annual report of the transactions of said Academy of Science shall be made on or before the 15th day of November of each year to the State Board of Agriculture, for publication in the annual Transactions of said board.

The Academy has increased in membership from the original small body of scientists to over 200. It has held thirty-nine annual meetings, of which nineteen have been held in Topeka, six in Lawrence, four in Manhattan, two in Leavenworth, two in Emporia, and one each in Atchison, Baldwin, Iola, McPherson, Ottawa, and Wichita.

Twenty volumes of the Transactions have been published, varying in size from a few pages in the early numbers to 350 pages in the later volumes. These publications contain many papers of recognized scientific value. The exchange list includes over 500 names of societies and libraries.

The Academy is now installed in the west wing of the capitol

building, at Topeka, in rooms on the ground floor. It has three connecting rooms, used for office, library, and museum.

The museum has been greatly increased by the gift of the state mineral display erected at the St. Louis Exposition, and given suitable cases to hold this large amount of material. It thus has the finest economic collection of the Kansas mineral industries in the state—an exhibit which received two gold medals, twenty-two silver medals, and fourteen bronze medals.

CONSTITUTION.

SECTION 1. This association shall be called the Kansas Academy of Science.

SEC. 2. The objects of this Academy shall be to increase and diffuse knowledge in the various departments of science.

SEC. 3. Members of this Academy shall consist of two classes, active and honorary (including associate). *Active members* may be annual or life members. *Annual members* may be elected at any meeting of the Academy, and shall sign the constitution and pay a fee of one dollar and annual dues of one dollar; but the secretary and treasurer shall be exempt from the payment of dues during the years of their service. Any person who shall at one time contribute twenty dollars to the funds of this Acadamy may be elected a *life member* of the Academy, free of assessment. Any member who has paid dues to the Academy for ten consecutive years, or who has been legally exempt during any portion of that time, may be elected a *life member* on the payment of ten dollars. Any member who has been a member of this Academy in good standing for twenty years may be elected a *life member* without payment of further fees or dues. *Honorary members* may be elected on account of special prominence in science, on the written recommendation of two members of the Academy. In any case, a two-thirds vote of members present shall elect to membership. Applications for membership in any of the foregoing classes shall be referred to a committee on applications for membership, who shall consider such application and report to the Academy before the election.

SEC. 4. The officers of this Academy shall be chosen by ballot at the annual meeting, and shall consist of a president, two vice-presidents, a secretary, and a treasurer, who shall perform the duties usually pertaining to their respective offices. The president, secretary and treasurer shall constitute an executive committee. The secretary shall have charge of all the books, collections and material property belonging to the Academy.

SEC. 5. Unless otherwise directed by the Academy, the annual meeting shall be held at such time and place as the executive com-

mittee shall designate. Other meetings may be called at the discretion of the executive committee.

SEC. 6. This constitution may be altered or amended at any annual meeting, by a vote of three-fourths of attending members of at least one year's standing. No question of amendment shall be decided on the day of its presentation.

BY-LAWS.

I. The first hour, or such part thereof as shall be necessary, in each session, shall be set aside for the transaction of the business of the Academy. The following order of business shall be observed, as far as practicable:

1. Opening.
2. Reports of officers.
3. Reports of standing committees.
4. Appointment of special committees.
5. Unfinished business.
6. New business.
7. Reports of special committees.
8. Election of officers.
9. Election of members.
10. Program.
11. Adjournment.

II. The president shall deliver a public address on the evening of one of the days of the meeting, at the expiration of his term of office.

III. No meeting of this Academy shall be held without a notice of the same having been published in the papers of the state at least thirty days previous.

IV. No bill against the Academy shall be paid by the treasurer without an order signed by the president and secretary.

V. Members who shall allow their dues to remain unpaid for two years, having been annually notified of their arrearage by the treasurer, shall have their names stricken from the roll.

VI. The secretary shall have charge of the distribution, sale and exchange of the published Transactions of the Academy, under such restrictions as may be imposed by the executive committee.

VII. Eight members shall constitute a quorum for the transaction of business.

VIII. The time allotted to the presentation of a single paper shall not exceed fifteen minutes.

IX. No paper shall be entitled to a place on the program unless the manuscript, or an abstract of the same, shall have been previously delivered to the secretary.

PRESIDENT'S ADDRESS.

"RECENT GROWTH OF ENGINEERING COLLEGES."

By F. O. MARVIN, Dean of the School of Engineering, University of Kansas.

RECENT GROWTH OF ENGINEERING COLLEGES.

By F. O. MARVIN, University of Kansas.

Presidential address, delivered at Topeka, November 30, 1906, before the thirty-ninth annual meeting of the Kansas Academy of Science.

IN looking over the field of recent engineering operations for indications of growth and unusual activity, far too much is discovered to warrant a simple notice even of all that is found.

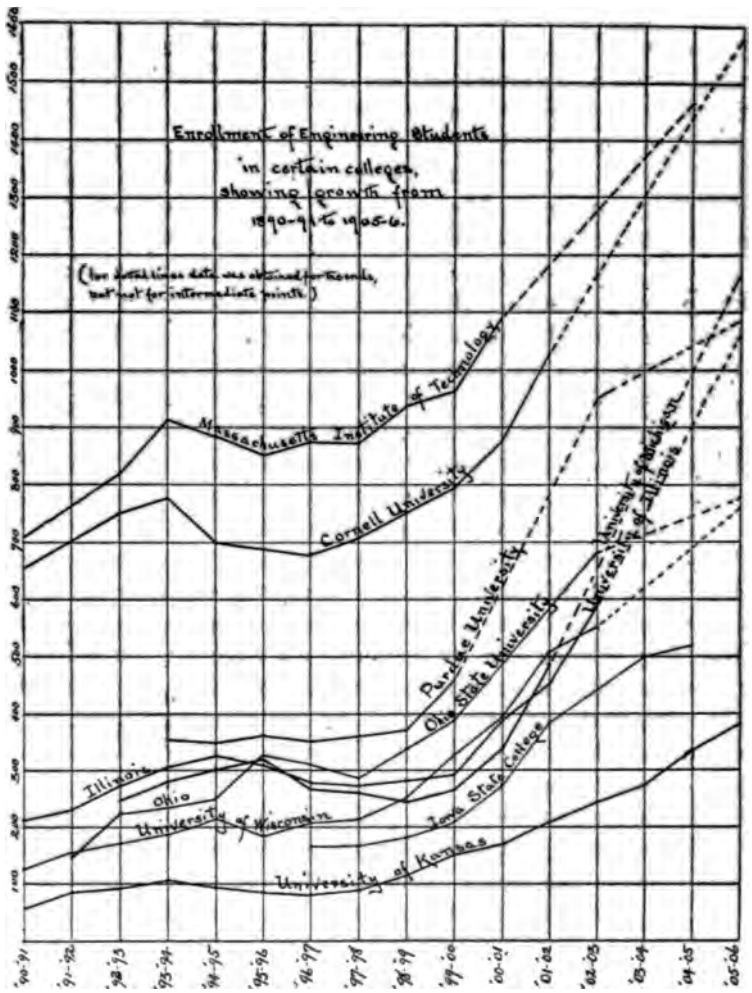
There are the great transcontinental lines, some new ones being built and others projected, and the double tracking and other improvement of old ones. There is the trend toward the substitution of electricity for steam locomotion, especially for service at terminals, and the development of interurban electric lines. The steam turbine has many achievements to its credit. The alternating current has been harnessed. Bridge and building construction is being revolutionized by the combination of concrete and steel, a matter made possible by a revolution in the methods of making Portland cement; a revolution so important for America that we are likely to wrest supremacy in the cement industry from Europe, as we not long ago forced her to yield her first place in steel. We are ushering in a cement age, as we then created a steel age. The gas-engine has come into prominence as a prime mover.

These and many others are great and interesting movements; yet the writer of this paper, being a teacher of engineering, and on this occasion speaking to a body of scientific people, most of whom are teaching science and its applications affecting the welfare of mankind, has chosen to turn to another great movement in which he has some part and about which he has some first-hand knowledge, and which, furthermore, lies beneath other movements as a basic or fundamental one.

To the teacher, indeed to every wide-awake and patriotic citizen, education is always an interesting and ever perennial topic, and to scientific people the recent rapid growth and development of the colleges of engineering in our land can but be of especial interest. This subject is a large and inexhaustible one, and only some phases of it can be discussed with any degree of adequacy within the limits of a brief address.

The report of the United States commissioner of education for the year 1899–1900 gives a total enrolment of students in universities, colleges, and schools of technology, exclusive of students in the pro-

fessional courses, of 98,923, of which number 11,874 were in engineering or architectural courses. The report for the year 1903–'04 gives, as corresponding figures, 118,816 for the total attendance and 21,087 for the engineers and architects. In these four years the increase in the total number of students attending college is 20.1 per cent., while for the technical students the increase amounts to 77.6 per cent., nearly four times as great a rate.



A study of the enrolment in a few of the prominent engineering colleges brings out certain general features common to all, as well as some differences. These institutions were chosen to represent different sections geographically, and which would therefore repre-

sent somewhat different surrounding conditions. They are the Massachusetts Institute of Technology, Cornell University, Purdue University, Ohio State University, University of Michigan, University of Wisconsin, University of Illinois, the Iowa State College, and the University of Kansas. The statistics given refer only to technical students, and the changes are shown graphically in the accompanying plate, for a part of which credit should be given to Prof. A. N. Talbot, of the University of Illinois, his diagram being extended and brought down to date. Beginning with the year 1890–'91, enrolments in all colleges show an increase up to 1894 or 1895 and then either a falling-off or practically a maintenance of numbers. This was due, no doubt, to the financial depression in the early '90's, which put a stop to so many public enterprises, lessening the demand for young engineers on the one hand and making their parents feel a monetary stringency on the other. But in the late '90's the schools began to feel the effects of the upward wave of prosperity, and their enrolments began to increase with a sharp rise about the year 1899–1900, the older Eastern schools taking the upward trend a year or two earlier. Since the beginning of the present century the rate of increase has been very remarkable, if not phenomenal, as is shown by the diagram, or by the subjoined table, covering the six years from 1899–1900 to and including 1905–'06.

GROWTH OF ENROLMENTS OF ENGINEERING STUDENTS IN CERTAIN COLLEGES.

Years 1899-1900 to 1905-'06.

COLLEGE.	Period beginning 1899-1900.	Per cent. of increase.	Average rate per year.	Enrolment last year.	Seniors in last year of period.
Mass. Inst. Technology	5 years.	52	10.4%	1,466	243
Cornell University	6 "	99	16.5	1,582	250
Purdue University	6 "	136	22.6	1,087	187
Ohio State University	6 "	99	16.5	787	73
University of Illinois	6 "	257	42.8	1,064	143
University of Wisconsin	6 "	136	22.6	768	113
University of Michigan	6 "	339	56.5	1,164	119
University of Kansas	6 "	153	25.5	379	33
Iowa State College	5 "	151	30.2	515	78

The percentages of increase in the case of the two Eastern colleges are relatively low, notwithstanding their rapid growth, because they already possessed large enrolments at the beginning of the period. They were also well equipped. The most remarkable expansion in numbers occurred with the group of institutions lying in the Mississippi valley. These found themselves placed under a

severe stress to provide for the instructional force and the equipment in buildings, laboratories and apparatus needed to properly care for the influx of students into engineering courses.

The growth of the Western schools has not been so spectacular, but has been none the less marked and real, and has led to the same pressing problems of administration, the same deficiencies in the number of instructors, the floor space required, and the equipment of drawing rooms and laboratories. In the institutions east of the Mississippi, the problems have been met and solved through legislative action, generously appropriating the necessary funds. The Western colleges, on the other hand, have felt the influence of the trend toward this form of scientific training, without the stimulus of generous legislative aid, for the lack of which they are now at this present time suffering. This is especially true in Kansas, where the state institutions have no distinctive engineering buildings and an inadequate equipment for the number of technical students already on the ground, to say nothing of the increased numbers that are sure to come in the immediate future.

The distribution of students between the various technical lines is interesting and is shown by the following table:

NUMBER OF STUDENTS IN VARIOUS TECHNICAL COURSES IN AMERICAN COLLEGES.

COURSE.	Year 1899–'00.†	1901–'02.*	1902–'03.†	1903–'04.†	Per cent. of increase in four years.
Civil engineering	3,140	3,694	5,278	6,118	90
Mechanical engineering	4,459	4,163	6,800	6,894	55
Electrical engineering	2,555	2,648	3,652	4,389	72
Mining engineering	1,261	1,453	2,244	2,324	84
Chemical engineering	.....	353	725	694	.....
Sanitary engineering	.....	.....	27	31	.....
Textile engineering	.....	.....	133	95	.....
Naval architecture	.....	81	.....	.....	.....
Architecture	459	362	558	542	18
Special engineering	.....	2,159	.....	.....	.....
Total	11,874	14,913	19,417	21,087	.....

* From proceedings of Society for the Promotion of Engineering Education.
† From reports of United States Commission of Education.

The above figures will show the recent trend as between the various lines of study chosen by students, but one can hardly say that this represents a permanent distribution, for the time covered is too short to warrant such a judgment. However, the introduction of courses in textile engineering in several Southern institutions is worthy of note as a new departure, as is also the increasing num-

ber of those choosing to enter the field of chemistry as applied to manufactures. This is a field that is promising as well as relatively new, and one that is not by any means fully occupied at the present. The increase shown by civil engineering seems somewhat abnormally large, although one looks naturally for that course to to show more growth in the last few years because of the widespread activity in public enterprises using the services of a civil engineer, and because the civil engineer graduate, from the less highly specialized nature of his college training, finds more possible openings before him and those of a greater variety and range than the graduate of other courses. In this the mining graduate is closely allied to the civil, though the recent increase in the numbers of those choosing mining is undoubtedly due to the revival in mining operations. The relatively low increase in the number of mechanical students is probably due to the popularity of electrical engineering, which, because of this popularity, due to its almost wizard-like accomplishments, has perhaps drawn unduly from its closely related course, that of mechanical engineering. Electrical engineering in reality is a branch of mechanical engineering, and it is a question not yet settled how far the two courses should be differentiated.

It is probably true that some of our courses in applied electricity in our colleges are too highly specialized along electrical lines and include too little of subjects found in mechanical courses to obtain the best training for all-round engineering work.

The falling out of students as they progress from year to year is also an interesting point. In the year 1901–'02, of the 14,913 students of technical courses in American colleges, only 1485 are classed as seniors. This is 9.9 per cent. For the college year 1905–'06, the Massachusetts Institute of Technology catalogued 16.5 per cent. of its total number of engineering and architectural students as seniors; for the last year, Cornell University, 15.8 per cent.; Ohio State University, 9.3 per cent.; Purdue University 17.3 per cent.; University of Michigan, 10.2 per cent.; University of Wisconsin, 14.7 per cent.; University of Illinois, 13.4 per cent.; Iowa State College, 15.1 per cent.; University of Kansas, 9 per cent. There are various reasons for this. The courses cover more ground and are made up largely of stiffer and harder work than is found in the ordinary college course, especially if the latter is one allowing of a wide range of electives; the engineering courses are more exacting then on a student's time and effort and many get weeded out early. Many students start with engineering under a notion that it is a good thing for them because it leads to

salaries, only to find that they are not adapted to that kind of work. Then the knowledge and training received in the years below senior, in times of great prosperity like this, become of money value, and many students from choice or necessity become wage-earners, or even engineers with limitations. This point operates strongly in Kansas. Another thing that influences the above percentages is the very recent rapid growth in numbers, which, of course, swells the ranks of the freshmen chiefly. Yet it is interesting to note that of the entire number of 118,000 students of collegiate grade in 1903–'04, only about 15,500 were given degrees at the end of the year. This is very close to 13 per cent., a figure which therefore can fairly be taken as an average for the whole country. There will come a time when more normal conditions will govern and the ratio of seniors to total number somewhat larger than above given. A strong influence in this direction is the growing tendency on the part of railways and manufacturing concerns to require graduation from a good technical school of those seeking engineering employment.

In the true professional schools (for the engineering school is not a professional school in any strict sense), the percentage of graduates to total enrolment is considerably higher, being 23 per cent. for law, 21 per cent. for medicine, 30 per cent. for dentistry, and 29 per cent. for pharmacy. The reasons for this probably are that those entering these professional courses are either more mature or more definitely settled in their choice than those entering college or a technical school. Moreover, the standards of work maintained by some professional schools have not heretofore been as high as those of the colleges, although there seems to be a general advance in this respect.

There is another point of interest to be touched upon growing out of this statistical study. The United States census for 1900 gives the number of engineers and architects in active practice, as follows:

Civil engineers	20,153
Surveyors	6,034
Mechanical and electrical engineers	14,440
Mining engineers	2,904
Chemists, assayers, and metallurgists	8,887
Architects	10,604
Designers, draftsmen, and inventors	18,956
Total	81,978

But, as the surveyors are rarely men of college training, as many chemists and most architects are not technically trained, and as the

class last mentioned above includes relatively only a small number of technical graduates, it is probable that the number of actual engineers at that date was not more than 50,000. Assuming that this number has increased to 53,000 at the present time, there is to be set against this body of practitioners the great body of 25,000 students, and we wonder what they are going to do, and ask whether this present trend of young men toward engineering is a healthful movement. We must look further to find an answer to the question.

It is said that the mean average growth of the number of wage-earners in America is about 3 per cent. per year, while the death rate is about 2 per cent. To provide for this growth and loss there would then be 5 per cent. of 53,000, or 2650 new engineers this year. If we assume 13 per cent. as the ratio of graduates to the total enrolment, as found above, this would furnish a body of 3250 with which to fill up the ranks. Hence, we might argue that the supply has reached or even overtopped the demand. Yet there is present another trend in modern affairs that sets this argument one side, and that is the growing recognition of the value of technical college training, followed by more or less of professional practice, as a basis for administrative business life. Engineers are constantly leaving the ranks of the profession for business openings, while young engineering graduates are accepting positions for which they are well fitted and in which they earn credit, but which can hardly be classed as strictly professional, although closely related thereto.

The truth is that any sound course in engineering is first of all educational, and professional only as a secondary matter. No school can make an engineer, for engineering as practiced is based on judgment, and this comes only as the result of experience. Some educators have tried to train young men into engineers, and some schools turn out graduates who believe that they possess technical wisdom, a notion that must needs be knocked out of them by hard experience before they can possess a sufficient amount of sense. The most that a school can do is to give a sound training, chiefly in mathematics and physical science and their applications, and an inculcation of principles, together with a small amount of professional knowledge, principally to help the young man to get a start without an exhibition of too much rawness. With it all, it must be recognized that the pupil is to be a man first and an engineer as a secondary matter. Indeed, he cannot succeed as an engineer without being true, honest, conscientious, simple-minded, open and frank, and without habits of hard work, of close and care-

ful observation, of weighing both sides of any point at issue, of searching for and clearly and strongly proclaiming the truth. Technical schools, in their laudable endeavor to fit men for practice, often for particular places, have sometimes lost sight of the real object of any right college work, and one of the encouraging things is another trend in engineering education that seeks to make more of the training of men as men without any real detraction from the scientific training.

That engineering courses are not professional is evidenced by the comparative ease with which young men, trained in one line in college, get into and succeed with another in practice. Civil engineers become miners, and *vice versa;* a miner becomes an expert in the cement industry; an electrical turns himself into a bridge engineer for a great railway. These and many other similar transformations have come within the writer's personal knowledge, as well as many instances of successful service in business or industrial life.

The young graduate, with his best acquisition a capacity for hard work, is somewhat the victim of circumstances and environment, and yet in the long run he will follow his bent and his natural likes. One becomes a scientific engineer, who loves his profession and his search for the truth in its problems, and who is content with a modest gathering of wealth. Another becomes a business engineer, attracted by the struggle of competition and the chances for accumulation. Both make use of their knowledge and scientific skill, but with slightly different aims. One seeks to obtain the best result for the least money expenditure; the other, so to plan that money returns may be the largest.

Our technical schools have largely planned their courses for the benefit of the first man, and it is a question that is now receiving consideration, whether they should not provide some specific training for the latter; and this is pertinent, because all engineers, of whatever type, necessarily must have to do with business affairs. It is certain that our engineering courses are strong in mathematics, the physical sciences, and their application and in drawing and design, at the expense of sufficient training in the use of English, a knowledge of the principles of economics, the elements of law, some study of business methods, the analyzing of the cost of production in manufacturing, some consideration of the principles of dealing with human nature and the handling of men, as well as some treatment of the matters of ethics and taste which materially affect a young man's outlook and his attitude toward life.

It is a serious matter to determine what to include and what to leave out in any four-year course of study, and in the present day this amount of time seems to be the maximum that one can expect to hold the great majority of students. Some things must be left out, and some left to be touched incidentally only through the personal influence of the teacher and his contact with the pupil. In the main, the engineering schools are quite close together as to their requirements, though courses of study are under constant discussion and are open to revision. In this matter there is no more potent agency at earnest work than the Society for the Promotion of Engineering Education, whose influence has been strongly felt in the thirteen years of its life.

There is yet another movement among the engineering colleges of very great import, not only indirectly to students, but directly to the public at large. This is a growing spirit of investigation, the attempt to take up and solve many scientific questions relating to the materials of construction, their use, or to methods of design. Twenty years ago there was very little of this kind of work done, outside of one or two institutions, and teaching was almost wholly led by practice; but to-day, the results of the thinking and investigation of the college men are leading the practitioners. The modern use of the alternating current grew out of the work of college men. The standardizing of the requirements for paving brick came from work done in a college laboratory. The Cornell hydraulic laboratory, with its unequaled opportunities, is open for the study of unsolved problems. The University of Illinois has published results of investigations concerning reenforced concrete, high-speed tool steels, the collapsing of tubes, the holding power of railway spikes, and the drainage of earth roads. The University of Wisconsin has made a valuable contribution to our knowledge of reenforced concrete. The Massachusetts Institute of Technology conducts postgraduate research work in sanitary engineering of great value. The Iowa State College is applying energy to investigations of economic value to the state. Indeed, there is hardly an institution of any great importance that is not doing some practical research work.

While the University of Kansas has done something along this line—investigations of building stone, paving brick, gas, oil, etc., and has in progress some study of stone for the improvement of roads, a systematic water survey of the state, in connection with the State Board of Health and the United States government, and other studies of public importance—the applied-science men of its

faculty have been too much occupied with the teaching function and too poorly supplied with space, equipment and money to warrant much development in this way. It is to be hoped that in the immediate future the state colleges of Kansas may be properly equipped to do systematic research work on economic engineering lines.

This movement is an exceedingly healthful one, for it adds strength and vitality to the teaching side of college life on the one hand, and furnishes scientific results of a high order on the other. College men are better adapted to study, investigate and draw unprejudiced conclusions concerning questions of this kind than any other class. They can have—indeed, are likely to have—a better equipment in the way of literature, laboratories, apparatus and other facilities as a basis for work; they are in close touch with workers in all scientific lines; only they must have both time for the work and available funds.

In conclusion, the writer believes that the trend of American youth toward colleges of applied science is a healthful movement, fully justified by the conditions of life as they now exist and will exist for many years to come; that applied-science college work furnishes a pretty severe training, leading to habits of industry, honesty in forming opinions, respect for truth, and a knowledge of how to attack and master real problems; that this training results in a class of men who bring things to pass; that it possesses a definite cultural value, though limited in its scope.

He further believes that applied-science colleges are but beginning their career of usefulness, not only as places for the higher education of youth, but also as centers of applied science, where investigations of utilitarian questions go on side by side with those of pure science—not simply side by side, rather with hand in hand; for no new truth of science is discovered but that, sooner or later, it is found to have its practical application somehow or somewhere.

He still further believes that every college of engineering, to rightfully fulfil its mission to both pupil and public, should include both functions, that of teaching and that of doing research work.

And finally, he believes that the spirit underlying the work of these colleges is such that they will not be content with present attainments and present standards of efficiency. Recognizing defects and limitations, they must and will struggle and work for better and higher results.

It is a serious matter to determine what to include and what to leave out in any four-year course of study, and in the present day this amount of time seems to be the maximum that one can expect to hold the great majority of students. Some things must be left out, and some left to be touched incidentally only through the personal influence of the teacher and his contact with the pupil. In the main, the engineering schools are quite close together as to their requirements, though courses of study are under constant discussion and are open to revision. In this matter there is no more potent agency at earnest work than the Society for the Promotion of Engineering Education, whose influence has been strongly felt in the thirteen years of its life.

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faculty have been too much occupied with the teaching function and too poorly supplied with space, equipment and money to warrant much development in this way. It is to be hoped that in the immediate future the state colleges of Kansas may be properly equipped to do systematic research work on economic engineering lines.

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He still further believes that every college of engineering, to rightfully fulfil its mission to both pupil and public, should include both functions, that of teaching and that of doing research work.

And finally, he believes that the spirit underlying the work of these colleges is such that they will not be content with present attainments and present standards of efficiency. Recognizing defects and limitations, they must and will struggle and work for better and higher results.

II.

CHEMICAL AND PHYSICAL PAPERS.

"COFFEE AND ESTIMATION OF ITS VALUE."
By L. E. SAYRE, University of Kansas, Lawrence.

"THE RELATION OF THE NEW FOOD AND DRUG LAW TO THE OFFICIAL PREPARATIONS."
By L. D. HAVENHILL, University of Kansas, Lawrence.

"DRUG STANDARDS WITH REFERENCE TO THE PURE FOOD AND DRUG LAW."
By L. E. SAYRE, University of Kansas, Lawrence.

"A MOST WONDERFUL TOOL."
By JOHN H. KLOPFER, Topeka.

"THE MODULUS OF LUNAR INFLUENCE—NOT IN A LIFTING, BUT IN A FALLING MOVEMENT."
By JOHN J. JEWETT, Sawtelle, Cal.

"THE SPECTRUM AND SPECTRUM SCALES."
By J. T. LOVEWELL, Topeka.

"THE QUANTITATIVE ESTIMATION OF IRON AND COBALT BY THE ROTATING CATHODE."
By R. W. CURTIS and S. A. MCREYNOLDS.

"NOTES ON KANSAS ROAD METAL."
By F. O. MARVIN, University of Kansas.

"THE DEVELOPMENT OF FOREST BELTS IN THE NORTHWESTERN PART OF CLAY COUNTY, KANSAS."
By JOHN H. SCHAFFNER, Columbus, Ohio.

"HELIUM IN NATURAL GAS."
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"A NOTE ON THE DETECTION OF CYANIDES."
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"NOTE ON MERCUROUS SULFATE FOR STANDARD CELLS."
By H. P. CADY, University of Kansas, Lawrence.

"A PROPOSED TEST FOR BLEACHED FLOUR."
By J. T. WILLARD, Agricultural College, Manhattan.

"ON SOME FERROCYANIDES OF CALCIUM, BARIUM, AND MAGNESIUM."
By F. B. DAINS, Topeka.

"DETERMINATION AND COMPARISON OF SOUND INTENSITIES."
By BRUCE V. HILL, Lawrence.

COFFEE AND ESTIMATION OF ITS VALUE.

By L. E. Sayre, University of Kansas, Lawrence.

IN volume II, page 50 (1887–'88), of the Proceedings of the Kansas Academy of Science, there is published an article by the author on the alkaloidal strength of teas. In answer to the question, Is the alkaloidal strength of tea an index of its commercial value? it was shown that a negative answer to this question must be given; that the alkaloidal strength has no relation to the commercial price. For example, it was shown that a tea rated at 25 cents per pound contained 2.49 per cent. of theïne, while a tea at 90 cents per pound contained 3.73 per cent. of theine, and that a tea at 60 cents per pound contained 3.67 per cent. of theine, showing that commercial price was no index to alkaloidal strength. Applying the same question to coffee, we have found the same to be true. A fine Mocha will contain about 0.64 per cent., while another of a different variety, and about the same price, will contain 1.53 per cent of caffeine.

In determinations of caffeine from coffee recently made in our laboratory, it has been found that the percentage of caffeine in coffee varies considerably according to the locality where it has been cultivated. Some coffees have ranked as high as 1.97 per cent. of alkaloid, while it is very commonly the case that an excellent coffee, commanding a good price, will yield as low as 0.8 per cent. of the alkaloid. The importance of this fact has never been applied as it might be, as there are some to whom the stimulating effect of caffeine is undesirable, while there is at the same time a demand for a beverage that shall have an agreeable taste. On the other hand, there are others to whom the stimulating effect of caffeine may be an advantage. The quality of roasted coffee is dependent mainly upon the substances which occasion the peculiar aroma. These substances have thus far been practically unknown. Erdmann, in *Berichte der Deutschen Chemischen Gesellschaft*, 1903, refers to the oil of coffee which has been obtained by treating roasted coffee with steam. The yield from 150 kilograms of roasted and ground Santos coffee was 83.5 gm., or 0.055 per cent., of an oil of a brown color, of a specific gravity of 1.0844, and a strong odor of coffee. On distillation of the oil, the greater portion passed over between 150 and 190° C. in the form of a light-colored oil. This contained furfur

alcohol, and much valerianic acid. The constituent having the characteristic aroma of coffee is said to be nitrogenous and not a phenol, as has been assumed heretofore. The exact isolation has not been possible so far. It is well known that the roasting of coffee carries with it antiseptic and deodorant properties. This is evidently inherent in the volatile products of roasted coffee, and possibly due to phenols present in these volatile products.

Our own experiments in the investigation of the volatile aromatic constituents of roasted coffee have led us to the conclusion that these when isolated are extremely volatile. For example, when chloroformic and petroleum ether solutions of the coffee are evaporated at extremely low temperatures it is found that the aroma evaporates and diffuses through the air at a lower temperature than that at which the ethereal liquids evaporate. We have endeavored, therefore, to resort to another method of recovering the volatile aromatic oil, which consisted in placing in a retort 500 gm. of finely powdered coffee and connecting the retort with a condenser and two receivers in tandem, the first receiver being refrigerated with ice and salt and the second refrigerated with liquid air. Only a few drops of a colorless liquid was recovered from the dry distillation in the second receiver. It is nearly colorless and has an odor suggesting that of capronic acid. It is very powerful and penetrating, diffuses very rapidly in the air, and when highly diluted with atmospheric air suggests the odor of coffee. The distillate obtained in the first receiver, of a yellowish-brown color, has an ammoniacal odor. But it is evident that the characteristic aroma of roasted coffee is due to a mixture of different compounds not obtained by any such process. We have not been able to pursue further this investigation, but hope at some future time to recover a sufficient amount of the distillate mentioned to purify the same and to make an analysis of it. The claim that oil of coffee may be obtained by distilling coffee with steam under pressure and collecting the distillate by means of ether and then evaporating the ethereal solution does not seem to us to be well founded, as we have not been able to obtain a volatile oil by this process which has the suggestion of the aroma of coffee. As we have said, ethereal and chloroformic solutions of the volatile products usually leave behind on evaporation little or no residue that are characteristic of the aromatics in coffee, these aromatics becoming evaporated on evaporation of the solvent, even though the solvent is evaporated at a very low temperature.

ANALYSIS.

In the analysis of coffee we have as yet no standard that would estimate the value of coffee from the commercial standpoint. The bureau of chemistry of the United States Department of Agriculture, in its standard for this beverage, makes the following statements:

1. Coffee is the seed of *Coffea arabica* L. or *Coffea liberica* Bull., freed from all but a small portion of its spermoderm, and conforms in variety and place of production to the name it bears.

2. Roasted coffee is coffee which by the action of heat has become brown and developed its characteristic aroma; it contains not less than ten per cent. of fat and not less than three per cent. of ash.

In Bulletin No. 90 of the bureau of chemistry of the Department of Agriculture, page 43, there are two processes mentioned for the determination of caffeine and caffeotannic acid, which I hereby transcribe:

Caffeine.

Method of Hilger and Fricke (*a*).—Take 5 to 10 grams of coffee, add 100 cc. of water, and boil, filter, and treat the residue twice more with boiling water. Add to the united filtrates an excess of lead acetate, filter, and wash. Treat the filtrate with hydrogen sulfid to remove the excess of lead, filter, wash, and evaporate the filtrate to dryness in a Hoffmeister schälschen with some sand and a little magnesia. Crush the schälschen between filter-paper, place in a continuous-extraction apparatus, and extract with chloroform until exhausted. Dry the chloroform extract at 100 degrees and weigh as caffeine. If the caffeine does not appear to be pure, determine the nitrogen in the residue by the Gunning method. $N \times 3.464 =$ caffeine.

Caffeotanic Acid.

Krug's method (*b*).—Treat two grams of the coffee with 10 cc. of water and digest for thirty-six hours, add 25 cc. of 90 per cent. alcohol and digest twenty-four hours more, filter, and wash with 90 per cent. alcohol. The filtrate contains tannin, caffeine, color, and fat. Heat the filtrate to the boiling-point and add a saturated solution of lead acetate. If this is carefully done a caffetannate of lead will be precipitated, containing 49 per cent. of lead. As soon as the precipitate has become flocculent, collect on a tared filter, wash with 90 per cent. alcohol until free from lead, wash with ether, dry, and weigh. The precipitate has the following composition: $Pb_3C_{15}H_{18}O_{82}$. The weight of the precipitate multiplied by 0.51597 gives the weight of the caffeotannic acid.

Dr. Wilhelm Autenrieth, in his work on the detection and estimation of alkaloidal substances, page 185, gives a résumé of the literature on the estimation of caffeine of caffeine-bearing plants, and gives six different methods. We have tried these various methods, and have found the Katz method to be the most satisfactory. This method is as follows:

Shake 10 grams of powdered coffee or tea for thirty minutes with 200 grams of chloroform and 5 grams of ammonium hydroxid solution. When the liquid has settled filter 150 grams of the chloroform solution, which should be perfectly clear and free from water. Distil the chloroform and dissolve the residue with gentle heat in about 6 cc. of ether. Add 20 cc. of 0.5 per cent. of hydrochloric acid and, in an assay of coffee, also 0.2 to 0.5 grams of solid paraffin. Evaporate the ether and filter the cold, aqueous solution. Wash the flask and filter-paper a few times with small portions of 0.5 per cent. hydrochloric acid. Finally extract the total aqueous hydrochloric acid solution four times with 20 cc. portions of chloroform. Distil the filtered chloroform extracts, dry the residue, and weigh. This residue will consist of nearly pure caffeine.

The one difficulty in all of these processes is that the caffeine recovered in the process contains some coloring matter or some empyreumatic matter imparting color to the product. It has been suggested that when the yield is thus contaminated the crystals be subjected to the Kjeldahl's nitrogen determination. The quantity of anhydrous caffeine is calculated on the basis of this analysis. One cc. of $\frac{N}{10}$ oxalic acid represents 0.00485 grams of anhydrous caffeine. Tetrachlormethane has been suggested by some analysts as a proper substitute for chloroform in the extraction of the alkaloid. We have found that an almost colorless caffeine can be obtained by properly using this solvent. It has been our endeavor to obtain a simple process by which we could estimate the caffeotannic acid and the caffeine at the same time. We have thus far had quite accceptable results by using a modification of the Krug method. Instead of using 2 gm. of the coffee, 7 gm. of the finely powdered coffee are taken. After digestion with the water and alcohol (as required by the formula) for twenty-four hours, 100 cc. of the filtrate, which is made to represent 5 gm. of the coffee, are taken. This is precipitated by the solution of lead acetate, and 60 cc. of the filtrate, representing 3 gm. of the coffee, are taken and treated with an excess of diluted sulfuric acid. The filtrate from the lead sulfate, which has been thoroughly washed, is carefully evaporated to remove traces of alcohol, and the residue is filtered into a separatory funnel and thoroughly washed with 15,

10, 10 and 5 cc. of chloroform, added in succession to the aqueous solution. The mixed chloroformic solutions are then evaporated to dryness and the resulting crystals of caffeine, if they contain an appreciable amount of coloring matter, are redissolved in a mixture of petroleum, ether, and chloroform, which gets rid of small quantities of color. This latter solution when filtered is evaporated and the crystals are weighed, and from the weight the percentage of alkaloid computed. The results that we have thus far obtained show concordant results. Samples of roasted coffee as obtained upon the market have given from 0.825 to 1.66 per cent. of caffeine, and of caffeotannic acid (or plant acids estimated as caffeotannic acid) from 10 to 12.8 per cent.

We desire to append to the present article the analysis of samples of coffee of different varieties which we have collated from the Proceedings of the American Pharmaceutical Association, volume 24, page 144, and, for the benefit of those who are interested in assay, we would call attention to the tables which accompany the most excellent article on the chemical constituents of coffee presented in Bulletin No. 90 of the Department of Agriculture, pages 43 to 45, inclusive.

ANALYSES OF SAMPLES OF COFFEE.

VARIETIES.	Caffeia.....	Fat.....	Mucilage...	Caffeotannic acid...	Cellulose...	Ash.....	Potassa.....	Phosphorus.
Finest plantation Jamaica.....	1.43	14.76	25.3	22.7	33.8	3.8	1.87	0.31
Finest green Mocha.....	0.64	21.79	22.6	23.1	29.9	4.1	2.13	0.42
Pearl plantation Ceylon.....	1.53	14.87	23.8	20.9	36.0	4.0	....	0.27
Washed Rio.....	1.14	15.95	27.4	20.9	32.5	3.5	....	0.51
Costa Rica.....	1.18	21.12	20.6	21.1	33.0	4.9	....	0.46
Malabar.....	0.88	18 80	25.8	20.7	31.9	4.3	....	0.60
East India.....	1.01	17.00	24.4	19.5	36.4	....	....	....

Proc. Am. Pharm. Ass'n, vol. 24, p. 144.

Paul and Cownley proved that a small amount of caffeine is lost in the roasting of coffee. To illustrate this, three samples are given: First, one roasted to extreme degree; second, one just far enough to give berries a fine chestnut-brown color; third, coffee roasted to pale brown color, when aroma was not fully developed.

COFFEE.	Loss of weight in roasting.	In raw coffee.	In roasted coffee.	
			Found.	E timated.
Low roasted.....	13.7%	1.10%	1.30%	1.28%
Medium roasted.....	16.0	1.10	1.36	1.31
High roasted.....	31.7	1.10	1.25	1.61

Proc. Am. Pharm. Ass'n. vol. 35, p. 142.

Julian E. Walker gives his results of the analysis of several kinds of roasted coffee for percentage of caffeine in different sorts:

Java	0.89%
Siberian Java	1.08
Salvador	1.01
Costa Rica	1.24
Mocha	0.54
Peaberry or Fenroll	0.77
Rio	1.12

Proc. Am. Pharm. Ass'n, vol. 38, p. 446.

ANALYTICAL RESULTS EMPLOYING VARIOUS SORTS.

W. T. A. Warner examined a large number of coffees in the laboratory of the colonial museum at Haarlem, conducting his researches with particular reference to the Siberian coffee cultivated in Java as a substitute for Arabian coffee:

Samples of Siberian Coffee.	H_2O Ext.	C_2H_5OH ext., per cent.	Fat, per cent.	Caffeine, per cent.	Ash, per cent.	Phosphoric acid in ash, per cent.	Potash in ash, per cent.
Sindjas	32.92	17.43	12.26	1.29	3.87	8.95	72.05
Timor	32.05	16.60	13.23	1.11	3.96	7.87	78.78
Banthain	30.38	18.89	14.78	1.11	4.29	10.26	77.83
Boengi	31.09	18.41	16.10	1.03	3.88	12.37	71.47
Loewae	30.13	17.82	16.06	1.48	4.30	11.25	79.90
Waloe Pengenten	26.98	17.85	13.57	1.25	3.97	9.47	76.91
Kaui Redjo	29.59	18.89	15.43	1.00	3.74	10.67	? rep.
Taman, Tjiasem	30.47	19.91	16.48	1.39	4.09	10.27	67.57
Malang	30.21	19.81	16.36	1.07	4.11	11.08	63.82
Averages	30.00	.....	15.00	1.00	4.00	.....	.....

The water extract was obtained by boiling five minutes with distilled water; the alcohol extract, by boiling during half an hour with ninety-five per cent. alcohol; the fat, by extraction with ether; the alkaloid, by one of three methods, viz., van Romburgh's, van Ledden-Hulseboch's, and George's, preference being given to van Romburgh's method, which consists in shaking out the aqueous extraction, after addition of lead acetate with chloroform.

The following table gives a comparison of raw and roasted Java-Arabia and Java-Siberia coffees. The extracts, unless otherwise indicted, are obtained by the action of each solvent on fresh portions of the same coffee. The coffees represent good qualities of the market during 1898.

	Raw Malang, per cent.	Roasted Malang, per cent.	Raw Liberia, per cent.	Roasted Liberia, per cent.
Aqueous extract	33.52	27.40	35.16	34.17
Alcoholic extract	19.38	16.12	18.62	17.27
Ether-alcoholic extract	17.70	16.53	15.80	15.92
Chloroform extract	15.65	17.91	13.88	15.10
Ether extract	13.63	14.20	12.19	13.13
Petroleum ether extract	12.51	14.31	10.84	11.68
Ether extract after petroleum ether	1.08	4.74	0.75	3.14
Chloroform extract after petroleum ether	1.08	1.41	1.18	2.60
Alcohol extract after petroleum ether	3.14	5.37	8.68	2.79
Nitrogen	2.83	2.77	2.73	2.89
Caffeine	1.16	1.57	1.59	2.19
Albuminoids	15.74	14.71	14.43	14.42
Cellulose	28.75	20.47	26.68	15.32
Pentoses	5.14	3.15	5.01	2.44
Ash	4.46	4.83	4.02	4.37
Water	11.24	5.64	11.40	3.98

Proc. Am. Pharm. Ass'n, vol. 48, p. 608.

CHASE & SANBORN COFFEE.

Ash, sample No. 1.. 3.98 per cent.
" " No. 2.. 3.92 "
" " No. 3.. 3.96 "

Total..... 11.86 per cent.

Average..... 3.95 per cent.

Samples:

A..... 0.196 per cent.
B..... 0.194 "
C..... 0.192 "

Av. moisture, 0.194 in 10 grams.
Present moisture, 1.94 per cent.

Ash:

3.89 per cent.
4.096 "
4.046 "
3.142 "

Av., 3.996 per cent.

Fat (Chase & Sanborn):

		Fat.	
50 gr.	8.0505	=16.101	per cent.
50 gr.	8.0980	=16.196	"
50 gr.	8.0275	=16.055	"
50 gr.	7.8708	=15.7416	"
50 gr.	7.9270	=15.8540	"

RELATION OF THE NEW FOOD AND DRUG LAW TO OFFICIAL PREPARATIONS.

By L. D. HAVENHILL, University of Kansas, Lawrence.

AT the present time, when so much is being said and written concerning wholesale adulteration and substitution, it is no wonder that people are becoming suspicious of almost if not quite everything with which they come in contact. That they feel their inability, as individuals, to cope with these alarming conditions is evidenced by their demand for legislative enactments for their protection.

This condition of affairs is especially true with reference to foods and drugs, substances so specifically essential to the health of the human family. These two classes of substances are usually grouped under a common head, especially in our statutes, though in reality they have little in common aside from their relation to the health of the individuals of the nation.

The United States government has for a number of years been actively engaged in the analysis of foods and the publication of methods for their analysis, and for the detection of their chief adulterants. It is, however, only recently that it has interested itself in the question of drugs and their adulterants, but it is interesting to note in this connection that it considered this branch of investigation sufficiently removed from the province of food chemistry to equip a new laboratory for this purpose, and to place it under the immediate direction of a man who is not only a trained pharmacist and chemist but one who has for years been actively engaged in the preparation and analysis of drugs and medicines. Several bulletins have already been issued by the chief of this new laboratory and many important problems are now in the course of solution. Aside from the activity displayed by the federal government in the interests of pure foods and drugs, several states are beginning to evince an activity in this direction, Kansas among others. This state has had for years a good law regulating the quality of foods and drugs, but it had almost become a dead letter through want of an enforcing officer. The last legislature, however, took action in this direction with reference to foods, and since January of this year a considerable amount of investigation has been done by the State Board of Health. This organization has also interested itself in the question of pure drugs, and there is

every indication that the next legislature will enact laws which will place Kansas in the front rank with those states that control the character of their foods and drugs.

The cause for adulteration in drugs is much the same as for adulteration in foods, and the remedies will be along the same lines. So long as our grandmothers gathered the yearly stock of medicinal herbs and dried them in the garret there was no more question concerning their efficacy than there was as to the wholesomeness of the food prepared by the same individual, but when the drug collecting, as also a very large part of the food preparation, passed from unselfish, loving hands into those motived very largely by a desire for pecuniary gain, people in general began to inquire more closely into their origin. In opposition to this class of individuals, whose aim primarily is perhaps not so much to defraud as to secure for themselves more of the worldly goods, came those who demanded the "square deal," and who began to devise simple tests whereby the quality of the crude article could be at least roughly ascertained. The discovery of alkaloids and other chemical principles in drugs, to which their therapeutic efficiency is very largely attributed, gave at once a chemical method for their valuation. The first vegetable drug to be valued by this standard was opium, the drug in which the first alkaloid was discovered.

The real beginning of the movement to secure uniformity in medicines antedates the first pharmacopœia, that of 1820, but the first pharmacopœia to contain chemical tests of any importance for the valuation of drugs was the United States Pharmacopœia of 1880. Here we find standardized by volumetric assay thirty-seven inorganic chemicals, six organic chemicals, and fifteen preparations for an inorganic constituent, besides a few gravimetric assays, including the assay of two drugs — opium and cinchona — for alkaloidal constitutents. In the next revision of this pharmacopœia the list of standards was much extended, and in the latest revision of this book, the eighth, commonly called the "United States Pharmacopœia of 1900," this list was still further extended. Comparing the number of quantitative tests in this book with those in the previous pharmacopœia, we find that where we formerly had only 114 volumetric and 14 gravimetric assays, we now have 149 volumetric and 35 gravimetric assays.

The articles standardized in the pharmacopœia of 1900 conveniently come under three heads: First, the chemical substances; second, the crude products derived from the vegetable and animal kingdom; and third, the preparations or the medicines compounded

from the first two classes. The chemical substances in the first class number about 300, and practically all of them are required to conform to certain prescribed chemical and physical requirements. The substances included in the second class, numbering about 240, are practically all accurately described, and about 50 of them have, in addition, a chemical method of valuation. In the third division, the preparations, there are 34 classes, which comprise 413 formulas. In 21 of these classes there is no attempt at standardization or description of any kind. In the remaining 13 classes there are 40 preparations for which there are volumetric assays, 17 preparations for which there are gravimetric assays, 1 preparation gasometrically assayed, and 18 preparations for which there are qualitative tests for purity only. This leaves 337 preparations in the pharmacopœia, or more than 80 per cent. of them, without any official description, definition, or standard.

The federal pure food and drug law which goes into effect January 1, 1907, states that drugs, and these are defined in the broadest sense of the term, so as to include, "all medicines and preparations recognized in the United States Pharmacopœia or National Formulary for internal or external use, and any substance or mixture of substances intended to be used for the cure, mitigation or prevention of disease of either man or other animals"—it states that these drugs "shall be deemed adulterated if, sold under or by a name recognized in the United States Pharmacopœia or National Formulary, they differ from the standard of strength, purity or quality as determined by the test laid down in the United States Pharmacopœia or National Formulary official at the time of investigation." Provision is made whereby these drugs may not be considered adulterated, provided they are properly labeled with reference to their quality. The National Formulary referred to is purely a book of formulas, without any so-called tests, either chemical or physical. Its formulas, 570 in number, are thus added to those of the pharmacopœia, making a total of 983 preparations, of which 907, or more than 92 per cent., are unstandardized.

The analysis of the preparations is by far the most difficult of the three classes of pharmacopœial substances, and it is here that the analyst who is not a trained pharmacist as well as an expert chemist needs to display the greatest caution, for surely the man without experience in putting these different drugs together is a poor judge of how to take them apart in a way to show whether the official formulas have been properly compounded or not.

The mere fact that a tincture which is prepared by extracting a given drug with diluted alcohol is found to be of lower alcoholic

strength is not necessarily an indication that the tincture has not been properly made, or that it is not of official quality. It is comparatively easy to decide whether a crude drug corresponds to the official definition and description, but after this drug has been broken into particles previous to making it into a preparation its quality is much more difficult to ascertain, and to judge of its quality from the finished preparation is unfortunately far too often an impossibility.

The absence of the physical characteristics from a preparation which are well known to the experienced druggist should go far towards condemning the preparation; but, on the other hand, their apparent presence is a poor guaranty for genuineness, for it is in this very particular that the skilful sophisticator takes pride in his iniquity and frequently outdoes himself. This is especially true in the case of colored and odorous preparations. Take, for example, the well-known tincture of vanilla; it is safe to say that but few people have any acquaintance with the pure article, and if they were allowed free choice between the pure and the factitious they would in the majority of instances choose the latter, though the relative value of it, based upon its actual cost, is not one-third that of the official article. It is in cases of this kind that the misbranding clause in the new law is especially pertinent. If you prefer the genuine, buy your tincture of vanilla, United States Pharmacopœia; if you prefer the factitious, buy the compound tincture of vanillin, National Formulary; if you belong to the don't-care class, continue to use the "extract of vanilla," which is generally inferior in quality to either of the others, and usually as high, if not higher, in price.

Besides the flavoring essences, the spices and condiments will also be affected by this clause, but in a way that will work to the good of the consumer. The result of adulteration in such articles, however, is of little moment when compared with the seriousness of adulteration in the realms of medicines proper. In this connection, it should be borne in mind that the further removed from the crude drug the medicine is, the greater the opportunity for adulteration and the less the chance for detection. In view of these points, and in spite of the new law, the fact still remains that the only safe way at the present time is to patronize those druggists whom you know as men as well as druggists and whose ability and integrity you know to be above question. If it is your desire to use cheap drugs, they can furnish them as cheaply as any one; but in any case do not begrudge them their just compensation for the knowledge and skill they place at your disposal in time of need.

DRUG STANDARDS WITH REFERENCE TO THE PURE FOOD AND DRUG LAW.

By L. E. Sayre, University of Kansas, Lawrence.

THE enactment of the pure food and drug law has brought to the front, as was expected, many important facts regarding the question of standards. In the first place, the United States Pharmacopœia has become of the greatest importance, inasmuch as the law requires that the standards for drugs and medicines shall be based upon that authority. The United States Pharmacopœia will have, therefore, far greater authority than heretofore. The National Formulary is also mentioned as a standard; but this standard work, which is far inferior to that of the pharmacopœia, is of much more recent creation.

The framers of the law, it would seem, were not familiar with two important facts concerning these two national standards. The law seems to indicate that the pharmacopœia has a test for all of the remedial agents mentioned; and the law also indicates that the National Formulary has standards for preparations it recognizes. Now, the facts are the United States Pharmacopœia does not prescribe tests for over fifty per cent. of the preparations it authorizes; and the National Formulary prescribes practically no tests whatever for assaying its preparations; therefore, the question of standards becomes a very important one.

It is said the pharmacopœia has been found, since the enactment of the pure food and drug law, to have standards and processes of assaying which in some cases should be amended. The manufacturers of chemicals and remedial agents have been greatly excited over this question. They have pointed out some errors of a minor character, it is true, some of them being plainly errors of figures, melting- and boiling-points, etc., which should be revised. It is plain that the committee of revision will be obliged to take up the question of correcting any errors and defective tests, and a supplement to the pharmacopœia will have to be issued. The work before the committee of revision will take some time, but it is to be hoped that the standards will be as high as they have thus far been prescribed, while at the same time there will be no injustice to the manufacturing industry nor to the consumer in making the few revisions proposed. It has been stated that there are a few tests in the pharmacopœia which are needlessly rigid. Undoubt-

edly this question will be considered, and in due time reported upon.

It should be stated in this connection that methods of assay or examination should be agreed upon for preparations of the United States Pharmacopœia and National Formulary, for which there are no prescribed tests.

Take, for example, the fluid extract of taraxacum. It is well known that there is upon the market an article which is sold as the American dandelion, and this is known to have been sold for taraxacum. The question occurs, How shall we assay the fluid extract of taraxacum to ascertain whether it has been adulterated with fluid extract of chicory? There is a method known to the pharmacist, but this is not mentioned in the pharmacopœia, nor have any tests been agreed upon for the purpose of standardizing such a preparation. Take another example, where we have the fluid extract of columbo. This has been adulterated with what has been known as American columbo, but there has been no prescribed method of assay or examination recognized in the pharmacopœia. The expert pharmacist is able to detect the presence of American columbo, but, as I have stated, no recognized method of examination has been adopted. It seems to us that cases of this kind will have to be seriously considered if we are to make the National Formulary and the United States Pharmacopœia effective as is intended by the pure food and drug law.

It is unfortunate that there should exist any ambiguities or misunderstandings as to standards, but this seems at the present stage inevitable. Still, it is quite possible for the pharmacist to take care of the medicinal preparations for which there is no test provided, by employing tests known to himself. This will have to be done until a uniform process of examinations of such medicinal preparations is agreed upon.

Some of our large manufacturers are very much exercised as regards the retroactive character of the law, which seems to be one of its features.

It is to be hoped that the manufacturers will find that they have overestimated the difficulties in view of the retroactiveness of the law. Under the guidance of such a man as Doctor Wiley, we feel, while the law will be rigidly enforced, the spirit rather than the letter will be made the principal feature; and if this is to be the policy, it seems to us that we shall not have any clamor on the part of manufacturers and wholesalers against it from this point of view. It is unquestionably true that manufacturers have shown not only

a willingness, but an earnest desire to comply with all the provisions laid down in the law itself, and are willing to cooperate in every possible way in making the same effective and practical in its operation.

In a current issue of one of the pharmaceutical journals, it refers to the law in these words: "Don't worry over the pure food and drug act of 1906, unless you sell goods in some state other than the one in which you live. Every article which you have in your stock January 1, 1907, may be sold to your home trade without restriction, and all articles which you receive after January 1, will be pure and will conform to the new law, and you will be held harmless under its operations, provided you purchase your supplies from a reputable house whose guaranty is registered at Washington." It further states that "we will guarantee that all articles of food or drugs manufactured, packed, distributed or sold by us, including both food and powdered drugs, chemicals, pharmaceutical preparations, medicinal specialties, proprietary medicines, etc., are not misbranded within the meaning of said act."

Few members of the community realize what an immense amount of work will be required for the manufacturer and wholesale dealer to comply with section 8 of the law relating to labeling by the time specified. The major part of the work on the part of the manufacturer and dealer lies in the direction of taking care of the stock which is already distributed among wholesale dealers and jobbers. Some are inclined to make the statement that if the law be rigidly enforced as to these already distributed goods it will be practically inoperative because of the difficulty of carrying out its provisions.

One firm has made the statement that it will require 100 extra men from this time on to go over the stock that is now distributed in the wholesale market, stored away in original packages, which will have to be opened and repacked, to say nothing of the goods that they are obliged to put out between now and January 1, if obliged to distribute them as they have been accustomed to do, for the reason that it will take them at least a month or more to readjust their different departments to comply with the law in connection with the goods that will be shipped after the 1st of January. We believe that, while there are a great many complications and numerous adjustments to be made, Doctor Wiley is going to take the position that the manufacturers of the country as a rule are honest and upright citizens. He said, in his interview with the manufacturers and proprietors of medicinal agents, that the execution of the law rested more in their hands than in the judicial de-

partments, and he hoped that the regulations would be so planned that there will never be cause for prosecution, and that the district attorney will never be called upon to press a suit.

Certainly if Doctor Wiley takes that position, as we believe he does, honestly and squarely, he will give, as the representative of the United States official, a fair and liberal treatment to those concerned in this great question.

It is evident that the principle which shall govern the department in Washington is that every article must bear a label which tells the truth, and if manufacturers put upon the market, knowingly and wilfully, substances which differ from the standards, that difference must be clearly stated upon the label. If that principle is carried out it will be a great boon to the profession of pharmacy and medicine. It will have the immediate effect certainly of making it easier for the pharmacist and physician to obtain good and reliable material, and the ultimate effect will be to raise the standard and dignity of the profession of pharmacy. We are therefore thankful for the law as it is, although it may have, as is frequently the case with new laws, certain imperfections and shortcomings.

A MOST WONDERFUL TOOL.

By JOHN H. KLOPFER, Topeka.

THE amazing adaptability of the steel square to the solving of a thousand and one problems in mathematics which puzzle the carpenter, will surprise those who know the square only as an instrument of measuring and squaring of boards and timber, and trying up angles.

In conjunction with the square it will be necessary to have a good four-fold, two-foot rule, with the duodecimo or twelfth scale marked on one of its outer edges. The outer edge of one side of the steel square, on both the tongue and blade, has each inch divided into twelfths. This is the side which will be mostly used, as each inch will represent one foot, and each subdivision one inch, or a scale of one inch to the foot.

The standard steel square has a blade 24 inches long and 2 inches wide, and a tongue 14 to 18 inches long, $1\frac{1}{2}$ inches wide. The blade is exactly at right angles with the tongue, and the angle formed by them is an exact right angle or square corner.

A proper square should have the ordinary division of inches, half-inches, quarters and eighths, and often sixteenths and thirty-seconds. Another portion of the square is divided into twelfths of an inch; this portion is simply a scale of twelve feet to an inch, and is used for any purpose, as measuring scale, drawing, etc. The diagonal scale on the tongue near the blade, often found on squares, is thus termed from its diagonal lines. However, the proper term is centesimal scale, for the reason that by it a unit may be divided into 100 equal parts, and, therefore, any number to the one-hundredth part of a unit may be expressed.

In this scale A–B is one inch; then, if it be required to take off $\frac{73}{100}$ inch, set one foot of the compass in the third parallel, under 1 at E, extend the other part to the seventh diagonal in that parallel at G, and the distance between E and G is that required. For E–F is one inch and F–G 73 parts of an inch. Upon one side of the blade of the square running parallel with the length will be found nine lines divided at intervals of one inch into sections or spaces by cross-lines. This is the plank, board and scantling measure. On each side of the cross-lines referred to are figures, sometimes on one side of the cross-line and often spread over the line, thus: 1/4-9/–. We will suppose we have a board twelve

feet long and six inches wide. Looking on the outer edge of the blade we find 12; between the fifth and sixth lines under 12 will be found 12 again. This is the length of the board. Now follow the space along towards the tongue till we come to the cross-line under 6 (on the edge of the blade), this being the width of the board; in the space will be found the figure 6 again, which is the answer in board measure, namely, six feet.

On some squares will be found on one side of the blade nine lines, and crossing these lines diagonally to the right are rows of figures, as seven 1's, seven 2's, seven 3's, etc. This is another style of board measure, and gives the feet in a board according to its length and width.

In the center of the tongue will generally be found two parallel lines, half an inch apart, with figures between them; this is termed the brace rule. Near the extreme end of the tongue will be found 24–24, and to the right of these 33–95. The 24–24 indicates the two sides of a right-angle triangle, while the length of the brace is indicated by 33–95. This will explain the use of any of the figures in the brace rule. On the opposite side of the tongue from the brace rule will generally be found the octagon scale, situated between the central parallel lines. This space is divided into intervals and numbered thus: 10, 20, 30, 40, 50, 60. Suppose it becomes necessary to describe an octagon ten inches square: draw a square ten inches each way and bisect the square with a horizontal and perpendicular center line. To find the length of the octagon line, place one point of the compasses on any of the main divisions of the scale and the other leg or point on the tenth subdivision. This length being measured off on each side of center lines, touching the line of the octagon, will give the points from which to draw the octagonal lines. The size of the octagon must equal the number of places taken off from the tongue by the compasses.

We shall now proceed to lay off the lengths, cuts and bevels for the timber in a hip roof 24 feet wide by 32 feet long, the hips to be at right angles and the roof to have a pitch of 45 degrees, leaving a ridge of 8 feet, the distance from the plate to the center of the roof being 12 feet, and the rise of the roof being the same, measure with the rule diagonally across from tongue to blade on the outside edge having the twelfth scale from 12 to 12. The distance on the rule will be 17 inches, or feet, the length of common rafter, and the figures 12 by 12 will mark the heel or seat cut, and also the plumb cut against the ridge board. It will be noticed that every foot gains five inches on the diagonal. Next

the length of the hip rafter is wanted. Measuring from 17 on blade to 12 on tongue (17 representing the length of common rafter, and 12 the inward distance of the hip from plate to ridge, the hip being the diagonal of these), the distance as shown on the rule will be 20 $\frac{10}{12}$, or 20 feet 10 inches. For the heel or seat cut take 12 x 17 on the square, and lay on the side of the timber and mark on the blade or 17-inch end, and on the tongue or 12-inch end for the plumb cuts. For the side cuts against the ridge board take 17 and 20$\frac{10}{12}$ and lay across the upper edge of the stick and mark on the 20$\frac{10}{12}$ edge. For the backing of the hip rafter dress a portion of its upper edge with a jack plane, and run a gage on its center; lay the square on with the length of the hip rafter or 20$\frac{10}{12}$ on the blade and 12 (the rise of the rafter) on the tongue; mark from the gage line to edge of timber on the tongue or 12-inch end, and then from the same point on center gage square straight out to the same edge; the difference between the two points at the edge of timber will be the distance to gage down on each side of the timber for the backing. Or, a bevel can be set to the scribe made on the top as described, and worked to. The rafter should not be backed until all the necessary framing of it is done. The next thing in order will be the framing of the jack rafters to fit in their places against the hip rafter. We will suppose that the rafters are spaced every two feet on the plate, and as we have seen that every foot gains five inches on the diagonal we know that each jack will be two feet ten inches longer as they range out from the angle of the plate. Dress off the upper edge of one of the common rafters, and allowing first for one-half the thickness of the hip rafter, space off a jack rafter every two feet ten inches on said common rafter. This will give the pattern or length for cutting every set of jacks. The side cut or bevel for the jack will be marked from the longest point by the figures 17x12 on the square; the plumb cut will be the same as that of the common rafters. To miter a purlin over or against a hip rafter, take 17 on the blade and 12 on the tongue and lay on the upper edge of the purlin in the direction of your cut, but this time scribe a mark on the 12-inch edge of the square; then turn the timber on its side, lay on the figures, and mark precisely the same way with the same figures, and the miter will be perfect, as you can test by taking the piece sawed off and reversing it against the cut; it will form the correct pitch and angle. If the roof is of different pitch, then different figures will have to be used, but the principle is the same. Supposing the roof has a rise of nine inches to the foot: if you

measure across the square from 12 on the blade to 9 on the tongue you will find 15 on the rule. Take 12 on the tongue and 15 on the blade, make the cutting mark on the purlin on the 12-inch edge, lay the timber on its side, and take 9x15 on the square, lay on, and mark across on the 9-inch edge, and the miter will be marked complete. So it will be seen that the figures which govern the pitch of the common rafters must be kept in mind all through.

A little practice with the problems above set forth will make the beginner familiar with the methods and enable him to comprehend the principles. The above will work out any problem of cuts in the framing of an ordinary roof. For the more complicated problems, such as cuts for irregular hip roofs, bevels of hoppers, cutting spring moldings, etc., a deeper study into the principles of the square is necessary.

THE MODULUS OF LUNAR INFLUENCE, NOT IN A LIFTING, BUT IN A FALLING MOVEMENT.

By J. J. JEWETT, Sawtelle, Cal.

IN the opinion of the writer, there is a general misconception of the immediate cause of the phenomena of the semidiurnal oceanic tides. I approach the subject very directly, that its discussion may not extend this paper beyond proper limits.

The usual explanation of the *modus operandi* of the moon's influence is very unsatisfactory to the ordinary inquirer, and especially that part of it which attempts to account for the tidal flow opposite the prolunar side of the earth. Perhaps the failure of the scientific expositors is due to a mistaken impression of how the moon's power is applied. The most important vantage is discarded or neglected. The pulling of the moon upon the waters of the prolunar geohemisphere is assumed to be the main cause of the tidal wave on that side of the earth, the sun coming in as an adjunctive or diversive agency, as the case may be. On the opposite hemispere the marine proturbance results from the unequal pull on the ocean bottom and the ocean surface, or, as some express it, by a pulling away of the land from the waters, "as it were," as a qualifying phrase, which, to use another metaphor, is putting the proposition into a ruminant's paunch for subsequent mastication. It is difficult to conceive the power thus attributed to the moon as really operative, while our senses give no indication of it in our physiological experience. It is still more difficult for the student to mentally perceive how the land and sea are pulled apart on both sides of the globe simultaneously.

I will endeavor to show a cause of tides more powerful than the moon's direct action, and the operation of which can be more easily comprehended, existing within the compass of the earth, and subject to the laws of gravity. The tendency of concrete bodies to approach each other is proportioned to the sum of their masses, modified by the spatial degrees of separation, diminishing as the latter increases, and augmenting as it declines in proportion to the square of any lineal unit or units of measure. That is to say, if their distance apart is doubled, the gravitational force is reduced to one-fourth its previous power; but if the original distance is reduced to one-half, the power is increased fourfold. Now, in spheres, if the mass is distributed symmetrically, the center of

gravity will be the center of the sphere, but if unsymmetrically, the gravity center will be eccentric with reference to the spherical center. The latter relation exists in the moon. But this incoincidence has no dynamic effect in a non-rotating sphere. In a rotating sphere this incoincidence becomes a very important source of dynamic action. The internal mass is constantly impelled to adjust itself symmetrically concentric to the middle point of the axis of rotation. The movements of adjustment engender heat, intense in dense matter, and are continuously and eternally operating while equilibrium is unsatisfied. This a law of gravity, everlasting, invariable, and instantaneous in action. The earth's center of gravity is, therefore, the central point of its axis of rotation.

The ratio of the moon's mass to that of the earth has not been certainly determined, but is assumed to be about as one to eighty, a convenient one to use in this connection. The geolunar gravity center is near the center of the earth. It would be if the two planets were in contact, but by reason of the distance of the eighty-first part from the main mass it is nearer. It is a constantly changing point, and the earth's center revolves about it monthly, at a varying distance regulated by the moon's perigee and apogee positions.

In an old edition of Burritt's Astronomy, a popular work forty to fifty years ago, the geolunar gravity center was placed at about 3000 miles from the earth's center. But this assumed distance seems to have been suggested on the principle of the steelyard. In modern works of astronomy and physics which I have consulted, but little reference to this important focus is to be found. That it must be near the earth's center is evident or the mensal revolution about it would be a very obvious and remarkable phenomenon in astronomical observations. But it is certain that it cannot be coincident or identical with the terrestrial center; if this were the case there would be no tides. Now, this eccentric destroyer of equilibrium cannot be eliminated by any rearrangement of the earth's materials, because it is a continually shifting point westward, northward, southward, centripetally and centrifugally. Yet it is the point towards which all the earth's substances are constantly pressing, keeping up an incessant churning of the fluid interior already under pressures of 2,000,000 to 3,000,000 atmospheres. The heat engendered must be beyond calculation, and it is not extravagant to suppose that gases as dense as metals on the surface mingle according to the law of gaseous diffusion. And yet this heat is not equivalent to what escapes from the surface, as shown

by the continued contraction of the crust. As we go from the center outwards the intensity of influence becomes rapidly less in proportion to the squares of distance from the heart of turbulence. The severity of action in the interior is due to the extreme influence of mass relative to volume from pressure, to the nature of its elements and to the comparatively great differences in distances between the geolunar gravity center and the various parts of the indeterminate core. A little way from this fountain of agitation the ratios of distance are much reduced, and at the surface are quite small. The tides are the last obvious phenomenon, the tail, indeed, of the moon's interference with mundane equilibrium. I say "obvious phenomenon," though, as a matter of fact, the petrosphere is subject to continuous vibrations, discernable at seismographic stations, similar to those affecting the most massive bridges under the strain of footsteps, moving vehicles, and winds. And the atmosphere gives some indications of response to the tumult of the centrosphere, but owing to its elasticity no perceptible movements of its matter can be traced with certainty to that cause.

I will now attempt to make clear the working of the tides, beginning with the aplunar geohemisphere, or that hemisphere farthest from the moon. The point on the surface of the ocean directly in line with the geolunar gravity center and the moon is the highest on the hydrosphere, because it is the most remote from that center. It is common observation that water "runs down hill." No fact in nature is better established as a matter of positive knowledge, and every grammar-school boy can tell why. He knows that all fluids seek a position not occupied by something heavier, nearest the center of gravity, generally regarded as the center of the earth, but really the geolunar gravity center. The flowing fluid is said to be seeking its level. This is what the waters of the ocean do; they seek a level, an equilibrium. In every direction they flow from this high point towards a lower one. If the high point were fixed it would soon vanish, for the water would attain its level and there would be neither high nor low point

Only the westward and the eastward retreat of the waters from the high point need be considered with reference to tidal action in general. The water seeking its level westward exerts its weight contrary to its rotational motion, and the latter is slowed; that seeking its level eastward, in the direction of rotation, accelerates its own velocity. The eastern land coasts of the continental areas with undiminished velocity collide with the west flowing, or retarded, water, and bury themselves in its breast, and this process

produces the tidal phenomenon of the eastern coasts. On the other hand, the accelerated eastern flow, striking the normally moving west coast lands, rushes over them and drowns them in its billows. Thus we have on one side the land plowing into the sea, and on the other the sea overwhelming the land.

Now, let us investigate the situation on the prolunar geohemisphere. Directly under the moon and exactly opposite the high point is the lowest spot on the face of the hydrosphere, which covers nearly three-fourths of the spherical area. It is the lowest because it is the one nearest the geolunar gravity center. It is the one spot toward which all the waters of the hemisphere are flowing in seeking their level. The waters to the west of it, flowing eastward, are the accelerated waters; those to the east, flowing westward, are the retarded waters; but they sustain the same relations to the coast-lines as on the other hemisphere. If we now connect the two hemispheres and trace the tidal sweeps from one to the other we find continuous flows from the high point to the low point, starting in opposite ways. The waters of the ocean are seeking their level precisely as the rivers do; as, for instance, the Sacramento and the San Joaquin, of California, from the northwest and southeast, respectively, find their level in the bay of San Francisco.

It is well known that water does not move as a solid body does—at the same rate of motion throughout its mass—but some parts move swifter than others, the free surface having lesser friction to overcome, and the deeper and denser, the greater, give to the visible current a rolling appearance; hence we habitually and correctly speak of the rolling wave, the rolling river, as "the flow of Isar rolling rapidly." In the tidal wave there is always a thin, wedge-shaped advanced stratum in front of the main mass, and a like stratum lagging at the origin of the flow. We may call the high and the low points described above the tidal poles. It is at these poles that the moving floods are most shallowed, and midway between that they are most thickened. When the poles pass the coasts, or, rather, when the coasts pass the poles, at the velocity of about 14½ degrees an hour, it is the extreme of ebb, and when they pass the midway points it is the acme of flood.

We may now consider the direct influence of the moon upon the earth's surface, without regard to the geolunar gravity center. If the moon's center were within 4000 miles of the earth's surface, the influence of the satellite upon the hydrosphere would be in the ratio of its mass to that of the earth's, and a pound normal of 7000 grains would be diminished in weight about 87 to 88 grains on

that spot of the prolunar hemisphere directly under the satellite; but being 60 times as far distant, its power is but $\frac{1}{3600}$ of what it would be in the assumed position; and if we allow its counterbalancing effect on the normal avoirdupois pound as $\frac{1}{40}$ of a grain, we make a very liberal concession. This is a ratio of 1 to 280,000 compared with the earth's influence in weight making. With this vast difference in degrees of ponderal powers, it seems like the shadow of a metaphor to attribute a capacity to our great sunlight reflector to pull up from the normal level millions of tons of water in opposition to nearly 300,000 times its own potency. But what we speak of as the subtrahend of terrestrial weight, or the pulling force of the moon, is really but an index of the tendency of the water to leave the earth and go to the moon, an impulse inherent in the water itself and not in any extrinsic pulling force, and which, measured by its tendency to remain, is as 1 to 280,000. It is true there must be a differential in degrees of tendency between surface waters and deep layers, but this is too slight to produce an observable effect. If a pulling power would draw the waters toward the eastern shores, it would draw them away from the western shores, and the tides there would be but the effect of their returning to the normal. It may be possible to measure mechanically with a torsion fiber and a long index finger over a large dial the supposed power of the moon. I am not aware that the attempt has been made. It would be a great triumph of skill and science, if successful.

Yet in that case how could the effect of the approach of the geolunar gravity center to the sublunar terrestrial surface be excluded from the elements entering into the difficult experiment and its results? Unfortunately the dynamics of the tides have been made a datum for calculating the moon's mass, with a likelihood of having derived too large a quantity as a conclusion. It is quite possible, if not probable, that its ratio of mass to that of the earth's is not even 1 to 100, instead of 1 to 80. If the satellite is an offspring of the earth, which appears a very proper inference from what we know of cosmic physics of solar action and extraplanetary conditions, it was born when our globe had a gaseous or liquid constitution from center to circumference, and was much more oblate than at present, and must be mostly composed of the lightest metals and metalloids. Nor is it probable that since that time it has ever enlarged its orbital circuit—on the contrary, it is more likely to have contracted it, for reasons which are given in another paper.

The action of the sun in gravity work is all direct, for the geo-solar gravity center is in the body of that governing fire-ball, and so of all the intra-Jovian planets, and, probably, of all the others. It may be that the planets themselves are responsible for much of the heat they receive from the sun, for the numerous eccentric gravity centers in that revolving and rotating star must cause an agitation and disruption of its entire constitution, with evolution of heat. This is no fanciful conjecture of what *may* be, but a certain result of admitted gravitational law.

Turning to the question of the moon's influence to affect the length of the siderial day, we have seen that the tides are mainly caused by the eccentricity of the geolunar gravity center to the purely terrestial center and the axis of rotation, and to rotation itself, and that the moon's direct influence is simply a slight abatement or augmentation, as the case may be, of the normal weight of terrestrial matter; in either case producing no result not offset by a counter result. Unless it can be shown that purely secular redistributions of matter, such as come from trade-winds and ocean currents, have an effect to check rotational velocity, we may dismiss the idea that the moon does.

The premises and chief corollaries of the theorem may be summed up in the following propositions:

The geolunar gravity center is the point which all the matter of the earth presses to attain.

It is eccentric to the axis of rotation and to the earth's center of gravity.

It is a constantly shifting point, thereby causing a perpetual churning of the earth's fluid or plastic matter in its efforts to distribute its masses in equilibrium concentric to it, evolving heat.

It affects the fluids of the exterior less than those of the interior, conformable to the second Newtonian law of gravitation.

The oceanic tides result from the same influences that cause the interior clash, and are essentially waterfalls of vast extent, intercepted by sections of solid crust above or slightly below the normal sea surface.

The direct influence of the moon only feebly effects the normal ponderal relations of terrestrial matter, and does not retard terrestrial rotation.

The solid, brittle upper strata of the earth's crust, lined below by the semiplastic and plastic cushions of mixed material, are affected to continuous vibrations of very mild degrees.

A concluding thought is this: We are indebted to the moon for

a habitable globe to-day. Without its existence as a heat producer in disturbing subterrranean tranquillity, the earth ere this would have become a cold, solid, asymetrical, non-rotating spheroid. It is impossible that a large composite body of fluid become solid from loss of heat and retain symmetrical distribution of mass about its center of figure. Some parts or segments of the same radial distance from the center, and in the same plane parallel to the equator, will cool sooner than the remaining segments similarly situated, and from various causes, and asymmetry will follow. With asymmetry and complete solidity rotation must cease, as in the cases of Mercury, Venus, the moons, and the asteroids. Wherever we find a planet with a moon, or with moons, we may infer a rotation and a fluid interior, and with moonless planets the absence of both.

THE SPECTRUM AND SPECTRUM SCALES.

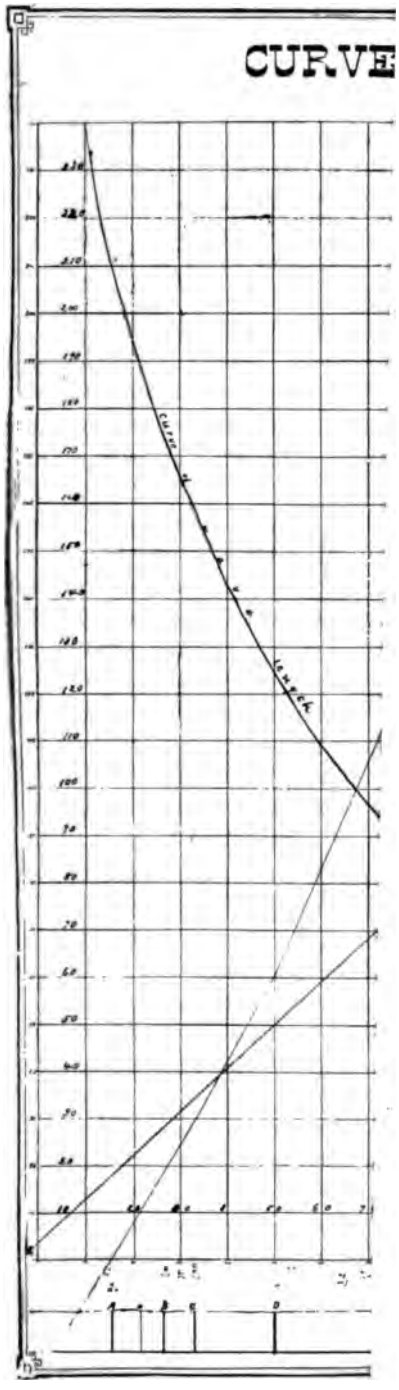
By J. T. LOVEWELL, Topeka, Kan.

IN the ordinary laboratory spectroscope we may often observe a line which we wish to compare, for identification, with numbers in the tables of Kirchhoff, or with wave-lengths as given in Angstrom's and similar charts. Perfect agreement of readings cannot be expected in different refraction spectroscopes, where lines are designated either by the angle of deviation or by the number of a photographed scale, which is brought into the field of view with the spectrum. Every prism has its own problem of refraction, and every photographed scale must have imperfections. In the diagram herewith presented use is made of curves, which are now employed in the discussion of so many physical problems. The spectroscope with which observations were made was a Duboscq single-prism instrument, with the ordinary photographed scale reflected into the field of the observing telescope. The scale numbers were from 1 to 200, and the first problem was to compare these with the numbers of Bunsen's charts of flame spectra. On a sheet of cross-section paper, ruled in inches and tenths, the lower margin was marked with the Bunsen chart numbers, which were to be the abscissas of the proposed curve. A few of the Fraunhofer lines of the solar spectrum are drawn in the margin as given in Bunsen's charts. For ordinates of the curve, readings of the spectroscope were used; for solar lines and for a great variety of flame spectral lines, obtained from soluble salts of metals, brought into the flame of a Bunsen lamp. The scale number of the observed line forms the ordinate of the curve, and these numbers are placed on the left-hand margin of the chart. The scale was adjusted so that the number 50 coincided with the sodium line or the Fraunhofer D line of the solar spectrum. The abscissas and ordinates of a large number of points in all parts of the spectrum were next found, and through the mean position of these points a curve was drawn which proved to be practically a straight line. Had the spectroscope employed by Bunsen been exactly like the one used here this line would have been at an angle of 45 degrees, but it was found to have an angle less than that, measured from the horizontal.

The Bunsen and Duboscq scales were supposed to be alike, as were also the prisms, but 50, the number to which they were adjusted, is the only point of exact coincidence where the lines cross.

When the Bunsen line of 160 is examined, the Duboscq number is 150. Drawn on the original scale the Duboscq curve is not quite a straight line, but has slight deviations, which are not noticeable when reduced to one-fourth the size, as in the diagram accompanying this paper. By the aid of this curve any observed line may at once be compared with the Bunsen charts. In a like manner a curve from Kirchhoff's scale numbers is prepared, only in this case the spectrum lines were obtained from the electric spark. It was by this means that Kirchhoff obtained most of his numbers. His spectroscope contained four prisms of flint glass, three of which had a reflecting angle of 45 degrees and the fourth an angle of 60 degrees. These were mounted on metallic stands with leveling screws, and suitably placed on a circular iron plate, upon the rim of which the telescopes were clamped. The light for the metallic spectra was obtained by three or four Bunsen elements acting on a large Ruhmkorff induction coil. A heliostat directed the solar rays upon the object-glass of his collimator, and his first care was to represent the lines of the solar spectrum as faithfully as possible, as they appeared in his spectroscope. The distance apart of the lines was measured by movement of an arm which was attached to the observing telescope, and this movement was estimated by the divided circle, with a micrometer screw attached. Record was made of the lines on a chart by means of a kind of equal-part machine, and the intensity and breadth of the lines were shown, the former by three shades of ink. Above the spectrum as thus exhibited he placed a millimeter scale, with a starting-point selected at pleasure. He chose such a position as brought the D line very near the 100 mark on the scale. After the solar spectrum was thus recorded, Kirchhoff proceeded to find the places of the metallic spectral lines as compared with the dark solar lines. To accomplish this he observed simultaneous spectra of the sun and of the metals. The solar beam was received into the upper half of the slit, and the metallic rays into the lower half, first falling on a glass prism so placed over the lower part of the slit that the ray, after a twofold total reflection, fell into the field desired.

The results of these observations were recorded with the same care as the former, and both were repeated until satisfactory agreement was obtained. Kirchhoff observed that a great difference resulted in the appearance of the lines as the temperature changed and as other vapors were present. Angstrom denies that there is any real change in the position of the lines, and takes issue with Plucker on this point. Kirchhoff's observations extended from


CURVE

the line D to somewhat beyond the line F, and his pupil and assistant, Hofmann, with the same apparatus and by the same methods, observed and mapped the rest of the spectrum from a little below A to a little beyond G. From the result of their labors we have what are commonly referred to as Kirchhoff numbers. Thalen with different instruments subsequently extended this scale to H. The Kirchhoff scale numbers are given in the right-hand margin of the diagram, and with these as ordinates, and the same abscissas before used, the Kirchhoff curve is drawn; and by comparing its ordinates with those having the same abscissa on the Duboscq curve, the identity of any metallic line seen by the Duboscq instrument may be established. The most exact designation of spectrum lines is doubtless by wave-lengths. The Swedish physicist, Angstrom, reduced the Kirchhoff numbers to wave-lengths, as well as greatly extended his observations, and the numbers taken from his charts are the abscissas in the wave-length curve here shown. The unit is one divided by 10 seventh power, expressed in millimeters, decimally 0.00000001 mm. It will be seen that the curve is tolerably regular and convex from the axis of abscissas. The wave-lengths are given in the right-hand margin, from 400 to 800 in units, as above indicated. We may thus find in any observation in this single-prism spectroscope the corresponding Bunsen chart numbers, the Kirchhoff numbers, or the wave-lengths.

Wollaston, in 1802, appears to have been the first to observe the dark lines in the solar spectrum which are always produced if the light falling on the refracting prism issues from a narrow slit parallel to the axis of the prism instead of a circular aperture, as in Newton's experiments. These lines were not carefully studied till 1814, when Fraunhofer, a celebrated Munich optician, took up the subject and carefully studied these lines. He designated seven different lines or groups of lines by the first seven letters of the alphabet, which continue to be the common names of these lines. He counted in the spectrum, obtained by his instruments, 574 lines. He devised a grating, made by winding fine platinum wire on the threads of two parallel screws, soldering the wire to them, and then cutting the wire away on one side. Letting his narrow beam of solar light fall on this grating, and making use of the principle of interference developed by Young, Arago, and Fresnel, he was able to measure the wave-lengths of many of these dark lines. It was not, however, till 1860 that Kirchhoff, by a splendid induction, explained the cause of these dark lines and demonstrated that the

spectroscope not only showed the constitution of earthly bodies, but could analyze the sun and stars.

No limit has been found in the number of solar lines, nor are they confined to the visible spectrum. Photography comes to our aid in studying the invisible spectrum, especially of the violet end. Wonderful improvements have also been made in the manner of obtaining the spectrum. In place of the grating of fine wires devised by Fraunhofer rulings are made on speculum metal with as many as 20,000 lines to the inch, by which the spectrum is spread out to twelve feet or more. These photographic charts far surpass the best results of Kirchhoff and Angstrom. In the chemical laboratory, however, the refraction spectroscope must remain the common instrument, and the method of curves herewith presented will be found a useful adjunct to its use.

THE QUANTITATIVE ESTIMATION OF IRON AND COBALT BY THE ROTATING CATHODE.

By R. W. Curtis and S. A. McReynolds.

THE application of a rotating cathode to the analytical determition of metals by electrolysis was introduced by Gooch in 1903, and the form of apparatus devised, and experiments with the same, are described in several papers from his laboratory.*

Mention is made that a rotating cathode had already been used in the arts for the purpose of secu-ing compact metallic deposits in electroplating.

Soon after the appearance of the first paper the use of a rotating anode for a similar purpose was described by Exner.†

The apparatus used by Gooch and Medway consisted of a small electric motor to the shaft of which, running in a vertical position, was fastened a rubber stopper. An ordinary platinum crucible was slipped on the stopper, electrical contact being made through a strip of platinum connecting with the shaft. A beaker containing the solution to be electrolyzed was raised upon a suitable standard until the crucible was immersed to within eight or nine millimeters of the edge. For anode a piece of platinum foil hung upon the inside of the beaker was used.

The crucible serving as cathode was revolved from 600 to 800 revolutions a minute. The current varied from 0.8 to 4.0 amperes, the corresponding current density per 100 sq. cm. being from 2.7 to 13.3. The time required for a determination was greatly diminished compared with that required in former electrolytic methods in which the ordinary stationary electrodes are used, being, in the case of copper, fifteen minutes on the average, zinc thirty minutes, etc. The results for a large number of experiments shown left nothing to be desired, varying in most cases but one- or two-tenths of a milligram from the correct values.

The metals experimented with, the results of which are shown in the above papers referred to, are copper, silver, nickel, cadmium, tin, zinc, and gold.

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* Gooch and Medway, Am. Jour. Sci., XV, 320 (1903). Medway, ib., XVIII, 56, 180 (1904), and Zen. amorg. Chem. 35, 414, etc.

† Exner, Jour. Am. Chem. Soc., XXV, 806 (1903).

The experiments reported herewith were carried out with apparatus quite similar to that described above. Copper was first tried, to show whether or not the right conditions had been secured. A solution of copper sulfate several times recrystallized was made, and standardized gravimetrically by a number of closely agreeing determinations made by precipitation with sodium carbonate, igniting and weighing the copper as copper oxid. The results and details are shown in table I. The solution to be electrolyzed was acidified with twelve drops of sulfuric acid 1:4, and occupied a volume of 65 cc.

TABLE I. Copper.

No.	$CuSO_4$ taken, cc.	Current, amp.	N. D., 100.	Speed per min.	Time, min.	Cu taken, gm.	Cu found, gm.	Error, gm.
1.....	20 00	1.5	8 9	687	15	0.1110	0 1116	+0 0006
2.....	20.00	1.5	8.9	687	15	0.1110	0.1112	+0.0002
3.....	20.00	1.5	8.9	775	15	0.1110	0.1117	+0 0007
4.....	20 00	1.5	8.9	750	15	0.1110	0.1110	±0.0000
5.....	20.00	1.5	8.9	750	15	0.1110	0.1111	+0 0001
6.....	20.00	1.5	8.9	812	15	0.1110	0.1110	±0.0000
7.....	20 00	1.5	8 9	775	15	0.1110	0.1111	+0.0001
8.....	20 00	1.5	8 9	800	15	0.1110	0.1110	±0.0000
9.....	*30.00	1.5	8 9	1,000	8	0.0760	0.0760	±0.0000
10	25 00	1.5	8.9	875	15	0.0634	0.0634	±0 0000
11.....	25 00	2 2	13.1	800	15	0.0634	0.0635	+0 0001
12.....	25.00	2.7	16.1	850	15	0 0634	0.0634	±0 0000
13	25.00	3.0	17.9	825	15	0.0634	0.0635	+0 0001
14.....	25.00	2 8	16.7	850	10	0.0634	0.0634	±0 0000

*A new standard solution made up.

The salt used for the estimating of iron was ferrous ammonium sulfate in ammonium oxalate sulution, 1:6, 50 cc After running for ten minutes the motor was stopped and the sides of the beaker were washed down, as was done with all the experiments with the rotating cathode. It was found that great care was needed in drying the deposit on the crucible by dipping in water, then in alcohol, and holding over a low flame of a Bunsen burner. The deposit was removed by dipping in concentrated hydrochloric acid for a few seconds, and came off in flakes. The completeness of the deposition may be tested at any time toward the end, by removing a drop of the solution, acidifying with hydrochloric acid, and adding potassium sulfocyanide. The results are given in table II.

TABLE II. Iron.

No.	Ferrous am. sulf. taken, gm.	Current, amp.	N. D., 100.	Speed.	Time, min.	Iron taken, gm.	Iron found, gm.	Error, gm.
1	0.4384	2.0	11.9	800	15	0.0625	0.0631	+0.0006
2.....	0.4000	2.9	17.3	800	15	0.0561	0.0563	+0.0002
3.....	0.4000	2.8	16.7	800	18	0.0561	0.0550	−0.0011
4.....	0.4000	2.6	15.5	800	18	0.0561	0.0561	±0.0000
5.....	0.4000	2.1	12.5	800	18	0.0561	0.0563	+0.0002
6.....	0.4000	2.1	12.5	800	20	0.0561	0.0560	−0.0001
7.....	0.4000	2.1	12.5	800	20	0.0561	0.0561	±0.0000
8.....	0.4000	2.2	13.1	750	20	0.0561	0.0563	+0.0002
9.....	0.4000	2.1	12.5	775	20	0.0561	0.0561	±0.0000
10.....	0.4000	2.9	17.3	800	15	0.0561	0.0563	+0.0002

For experiments in the estimation of cobalt the nitrate was used, the solution being standardized by conversion to the oxid and reducing in a Rose crucible with hydrogen. The results follow:

TABLE III. Cobalt.

No.	Cobalt nitrate sol. taken, cc.	Ammonium oxalate, gm.	Current, amp.	N. D., 100.	Speed.	Time, min.	Cobalt taken, gm.	Cobalt found, gm.	Error.
1	25.00	2.5	2.0	11.9	800	32	.....	Lost.	.....
2	25.00	2.0	2.0	11 9	800	35	.....	Lost.	.....
3	25.00	2.0	2.0	11.9	800	32	.....	Lost.	.....
4	25.00	2.0	2 0	11 9	800	35	0.0600	0.0597	−0.0003
5	25 00	2.0	3 0	17.9	800	30	0 0600	0.0598	−0.0002
6	25.00	2 0	2.4	14 3	800	35	0 0600	0 0598	−0.0002
7	25.00	2.0	2.4	14 3	800	33	0.0600	0.0599	−0 0001
8	25 00	2.0	2.5	14.9	800	35	0.0600	0 0605	+0 0005
9	25.00	2.0	2.5	14 9	800	30	0 0600	0.0588	−0.0012
10	25.00	2.0	2 8	16 7	850	25	0.0600	0 0599	−0 0001

These results indicate that, as was to be expected, the application of this method may be extended to include the determination of other metals, and must prove a valuable addition to the processes at the disposal of the analytical chemist on account of its accuracy and rapidity.

We wish to express thanks to Prof. E. H. S. Bailey for interest and encouragement, and to Dr. H. P. Cady for helpful suggestions and the loan of apparatus.

NOTES ON KANSAS ROAD METAL.

By F. O. MARVIN, University of Kansas, Lawrence.

LAST year, Mr. N. M. McGillivray and Mr. E. H. Dunmire, seniors of the school of engineering of the University of Kansas, undertook an investigation of the various kinds of stone in the eastern part of the state to determine their relative value for the making of good roads. The work was carried on through the year, and an abstract of the results is hereby given.

The road laboratory is equipped with a Deval machine for testing resistance to impact and abrasion, a battery of Abbe flint-jar mills for fine grinding, a hydraulic press for making briquets from the fine dust, a Page cementation machine for breaking these briquets, and an apparatus for the freezing test. The collection of the stone was largely due to the aid of Professor Haworth, of the the Geological Survey.

The methods followed in making the tests were in the main those used by the road laboratory of the United States government. The Deval machine consists of a battery of four iron cylinders, 20 centimeters in diameter and 34 centimeters in length, set at 30 degrees to the axis of revolution. In each is placed five kilograms of dried stone broken to a standard size, to pass a six-centimeter ring and returned on a three-centimeter one. The cylinders are then closed with an air-tight cover and rotated at the rate of $33\frac{1}{3}$ revolutions per minute for a total of 10,000 revolutions. The per cent. of loss of weight caused by this action is taken as representing the value of the materials tested to resist impact and abrasion. The lower this per cent. the better the stone. In French practice it was found that the best stone for road purposes lost about 20 grams per kilogram, or two per cent. This figure 20 then was fixed as a standard of excellence and a formula $\frac{20 \times 20}{W}$ adopted as a coefficient to represent the comparative value of various stone, W being the weight in grams per kilogram of the loss in the Deval machine. The larger this coefficient the better the stone. This test has been standardized and adopted as being the best index of a stone value yet devised, although not alone conclusive.

The cementation test is designed to bring out a stone's cementing and binding power. For this, one kilogram of stone broken to small pieces is ground up to very fine dust in the porcelain jar

pebble mill. This dust, sifted through No. 7 bolting cloth, is mixed with water into a stiff dough, allowed to stand for twenty-four hours in tight jars, and then pressed by hydraulic power, with a maximum of 100 kilograms per square centimeter (1400 pounds per square inch), into cylinders one inch high and one inch in diameter (2.5 centimeters). These are oven-dried for twenty-four hours and then broken by blows in the Page machine. The blows are given by a one kilogram (2.2 pounds) rain falling a distance of one centimeter, the number of blows needed to fracture the briquet being taken to represent the cementing power of the material. Five briquets were tested for each sample. This test is of great value, but the methods of making it have not as yet been worked out with entire satisfaction. An impact test of a rain, falling in a small machine like a pile-driver on a small block cut from the actual stone, is often made, but this is not included in this series.

In the freezing and thawing tests, ten pieces of the stone to be tested were first dried thoroughly, then saturated, and frozen by being placed in the open air. When the temperature fell to 20 degrees F. or lower, the stone was considered sufficiently frozen. The stone was then thawed by steam, resaturated, and again frozen. After as many alternate freezings and thawings as would be obtained last winter, the loss of weight was determined. Also the stone that had been subjected to this process was put through the Deval machine and its loss by abrasion compared with that of unfrozen samples. The results have not been very satisfactory, because of the limited cold weather of last winter, the insufficient number of tests, and the experimental stage of the matter. On all samples tested there was a slight loss, due to freezing and thawing, varying from 0.28 per cent. to 1.25 per cent. The Deval test on stone subjected to the freezing test showed a loss sometimes larger and sometimes smaller than that from untreated stone. It is likely that the test may prove of some value, but there has been too little work done to warrant any conclusions.

Determinations of weight, specific gravity, porosity and absorption were also made.

Following is a table showing the results of the tests of the years 1905–'06:

TESTS OF KANSAS STONE AS TO VALUE FOR ROAD MAKING.

LIMESTONES.

Number	Location.	Geological name of stratum.	Loss: abrasion and impact	French coefficient.	Specific gravity	Porosity	Absorption	Loss by freezing test	Number of blows, cementation test
1	McCune	Fort Scott	3.67%	10.9%	2.69	0.89%	1.46%	.....	.....
2	Coffeyville	Coffeyville	5.07	7.9	2.68	0.52	0.87	.....	.....
3	Chanute	Iola	4.29	9.3	2.69	0.54	0.90	.....	.....
4	Iola	"	9.38	4.3	2.66	3.36	5.13	.....	.....
5	Osawatomie	"	4.25	9.4	2.70	0.02	0.04	.....	.....
6	"	"	5.41	7.4	2.68	0.80	1.31	.....	.....
7	Rosedale	"	5.36	7.4	2.85	2.68	4.43	.....	.....
8	Argentine	Silicious	4.66	8.8	2.67	0.48	0.78	.....	.....
9	"	Iola	5.69	7.0	2.71	0.32	0.32	.....	.....
10	Garnett	Stanton	3.40	13.0	2.68	0.48	0.79	.....	.....
11	Ottawa	"	5.62	7.1	2.64	1.42	2.26	.....	.....
12	"	"	4.54	8.8	2.69	0.54	0.89	.....	.....
13	"	"	5.94	6.7	2.67	2.22	3.49	.....	.....
14	"	"	4.91	8.2	2.72	0.69	2.72	.....	.....
15	Leavenworth	"	4.53	8.9	2.45	1.22	1.99	.....	.....
16	"	Oread	7.00	6.1	2.59	2.48	3.77	.....	.....
17	Lawrence	Kickapoo	4.55	8.8	2.68 2.67	1.40 1.08	2.26 1.75	0.44%	46
18	"	Oread	4.32	9.3	2.64	0.62	1.01	0.28	8
19	"	"	4.21	9.5	2.66	1.89	2.99	0.54	.....
20	"	"	5.91	6.8	2.72	3.16	4.95	0.42	.....
21	Williamsburg	"	5.82	6.9	2.59	2.26	3.44	.....	.....
22	"	"	3.69	10.8	2.72	0.76	1.17	.....	.....
23	Atchison	"	9.41	4.6	2.57	1.99	3.03	0.45	35
24	"	Lecompton	5.75	7.2	2.66	1.50	2.41	.....	.....
25	Jefferson co.	"	6.00	7.4	2.61	2.29	3.53	0.33	10
26	Oskaloosa	Deer Creek	4.45	9.0	2.67	1.08	1.75	.....	.....
27	"	"	5.59	6.9	2.59	1.09	1.72	.....	.....
28	Tevis	"	4.58	8.7	2.67	0.58	0.95	0.75	5
29	Valley Falls	Topeka	4.15	9.7	2.69	0.58	0.97	.....	.....
30	"	"	6.12	6.7	2.68	1.09	1.77	.....	.....
31	"	"	6.03	6.7	2.68	2.10	3.34	.....	.....
32	Muscotah	Burlingame	3.58	11.4	2.69	1.60	2.58	.....	.....
33	"	Wabaunsee	3.13	12.9	2.71	0.71	1.17	.....	.....
34	Americus	Thin stratum	7.51	5.5	2.59	1.79	2.76	1.19	131
35	Americus	Americus	14.92	2.9	2.59	3.02	4.53	.....	.....
36	Allen	Thin stratum	4.74	8.5	2.69	1.28	2.07	0.59	49
37	"	Americus	6.13	6.4	2.59	3.95	5.81	.....	.....
38	Dunlap	Cottonwood Falls	8.71	4.6	2.72	2.05	3.32	.....	64
39	Holton	Wabaunsee	5.15	7.9	2.59	2.29	3.50	.....	.....
40	Soldier	"	6.25	6.6	2.58	2.63	3.97	.....	.....
41	Seneca	"	6.03	7.3	2.63	1.30	2.09	.....	.....
42	Frankfort	"	5.43	7.5	2.37	.....	.....	.....	.....
43	"	"	4.50	10.5	2.48	1.53	2.28	.....	.....
44	"	"	6.73	6.0	2.62	3.08	4.66	.....	.....
45	"	"	9.27	4.3	2.54	3.76	5.47	.....	.....
46	"	Cottonwood Falls	8.85	4.5	2.54	1.91	2.89	.....	.....
47	Helmick	.....	16.73	2.4	2.38	4.13	5.84	0.67	32
48	Dwight	.....	30.08	1.3	2.31	2.05	2.83	0.84	12
49	Junction City	Fort Riley	14.92	2.9	2.50	5.62	7.74	0.73	19
50	Silverdale	.....	20.55	2.0	2.58	5.73	8.05	0.28	.....
51	El Dorado	.....	6.77	6.0	2.64	8.31	11.21	1.25	220
52	Marion	Marion	15.24	2.8	2.67	8.71	11.80	.....	.....

CHERT.

53	Alta Vista	Cherty lines	10.51	3.8	2.62	3.14	4.75	0.92	38
54	Galena	Joplin flint	3.66	10.9	2.37	5.86	7.32	.....	4

SANDSTONE AND DRIFT.

55	Redfield	Bandera sandstone	7.81	5.1	2.60	3.09	4.66	.....	49
56	Lawrence	Drift boulders	2.22	22.2	2.64	0.03	0.05	.....	.....
57	"	"	2.54	15.8	2.66	0.09	0.16	.....	.....
58	"	"	1.51	26.6	2.40	0.09	0.15	.....	.....

PAVING BRICK, FOR COMPARISON.

59	*Coffeyville*	.....	5.40	7.4	2.44	1.50	2.21	.....	.....

An examination of results shows that the farther west one goes the softer, lighter and more absorbent the rocks become, that the cementing value cannot be inferred from external appearance or from the results of other tests. Much more work is needed, as the present series is not extended sufficiently to warrant drawing definite conclusions.

If the results of the Deval test are taken as an index of relative value and expressed by means of the French coefficient, the best stone examined in this series ranges as follows:

No. 10....	Garnett, Anderson county	13.00
No. 30....	Muscotah, Atchison county	12.85
No. 33....	Muscotah, Atchison county	11.40
No. 1....	McCune, Crawford county	10.90
No. 21....	Williamsburg, Franklin county	10.80
No. 43....	Frankfort, Marshall county	10.45
No. 29....	Valley Falls, Jefferson county	9.65
No. 19....	Lawrence, Douglas county	9.50
No. 5....	Osawatomie, Miami county	9.40
No. 3....	Chanute, Neosho county	9 30
No. 18....	Lawrence, Douglas county	9 30

As to the rank of our limestones as compared with those of other sections, again using the Deval test as a basis, the following figures may be given: Thirty-five Maryland samples gave an average coefficient of 9.34; twelve Massachusetts samples, 10.4; thirty-three samples from all over the United States, 6.51; the fifty-two samples of this series from Kansas, 7.16. Leaving out the softer from Morris, Geary, and adjoining sections, the results would compare favorably with the above figures.

This investigation of Kansas stone for Kansas roads is being continued this year, and it is hoped to obtain more data and larger results.

DEVELOPMENT OF THE FOREST BELTS IN THE NORTHWESTERN PART OF CLAY COUNTY, KANSAS.

By JOHN H. SCHAFFNER, Columbus, Ohio.

THE development of forest belts in the northwestern part of Clay county is confined to the bottom lands and bluffs along the Republican river and its tributary creeks. The two main creek systems are Mulberry creek and Five creeks, the sources of both being to the west, in the eastern part of Cloud county. These creeks and their branches lie for the most part in Mulberry, Bloom and Five Creeks townships.

The rocks in the region belong to the Dakota group, except toward the southeast, where the upper part of the Permian limestone begins to outcrop. The soil is thus decidedly sandy, on account of the great abundance of Dakota sandstone, although clays are also abundant. The character of the soil seems to have some influence on the distribution of certain trees and shrubs, for a number of species flourish across the line in the Permian limestone region which are not found in the Dakota.

The Republican river has a wide flood-plain, and in some places the timber belts extend outward a quarter of a mile, though usually much narrower. The woody plants in the river valley in Bloom and Mulberry townships are as follows:

TREES.

Salix amygdaloides Anders.
Salix missouriensis Bebb.
Populus deltoides Marsh.
Juglans nigra L.
Ulmus fulva Mx.
Celtis occidentalis Mx.
Morus rubra L.
Cercis canadensis L.
Gleditschia triacanthos L.
Gymnocladus dioica (L.) Koch.
Acer negundo L.
Fraxinus lanceolata Borck.

Farther down the river valley *Quercus macrocarpa* Mx. is abundant, but it seems to be practically limited to the Permian outcrops in this region. *Salix nigra* Marsh. may occur also, since it was found in Ottawa county, which joins Clay on the southwest.

SHRUBS AND SHRUB-LIKE TREES.

Salix cordata Muhl.
Salix fluviatilis Nutt.
Ribes missouriensis Nutt.
Rosa arkansana Porter.
Rubus occidentalis L.
Prunus americana Marsh.
Prunus watsoni Sarg.
Amorpha fruticosa L.
Amorpha canescens Pursh.
Euonymus atropurpureus Jacq.
Rhus glabra L.
Cornus asperifolia Mx.
Sambucus canadensis L.
Symphoricarpos symphoricarpos (L.) MacM.
Symphoricarpos racemosus Mx.
Cephalanthus occidentalis L.

In passing up the creek valleys, one meets another shrub, *Prunus virginiana* L. *Rosa arkansana* and *Amorpha canescens* are more properly prairie plants, but invade the forest belt to some extent. All of these shrubs are found in the creek valleys to nearly the upper limit of tree growth, except *Cephalanthus Prunus watsoni*, and *Euonymus*.

LIANAS.

Smilax hispida Muhl.
Clematis missouriensis Rydb.
Menispermum canadense L.
Rhus radicans L.
Celastrus scandens L.
Vitis vulpina L.
Parthenacissus quinquefolia (L.) Planch.

Along Mulberry creek the continuous forest belt ceases about five miles west of its mouth, while the discontinuous belts extend about four miles farther. In passing up the creek valley the five typical trees are box-elder, Green ash, White elm, Honey-locust, and hackberry. Along these are occasional cottonwoods, Peach-leaf willows, or Red mulberries. The Green ash is the first to disappear, usually several miles before the discontinuous forest belt ceases. The remaining four species extend to the limit of tree growth, with an occasional cottonwood or Peach-leaf willow. Half a mile beyond the river belt not an individual, young or old, was seen of the following species: Black walnut, Slippery elm, redbud and coffee-bean. Near the upper limits of the creek the banks are lined with *Amorpha fruticosa* and occasional clumps of Peach-leaf willows. The Poison ivy is the most aggressive of the lianas and extends to the very limits of shrubs and tree growth.

The conditions on Five Creeks are practically the same. North creek, which is a prominent tributary, extends through the southern part of Bloom township. The Green ash is the least progressive up stream of the five typical trees. As one passes near the limits of the continuous forest belt the box-elder is the most abundant, with White elm, Honey-locust, hackberry, Peach-leaf willow, and cottonwood, in about the order named. The shrubs and lianas are similar to those on Mulberry creek. At the upper end of the creek, most of the woody plants are on the steep grassless bluffs, especially on those facing the north. At the mouth of the Five Creeks, which is on the border of the limestone region, the following trees are present:

Salix amygdaloides Anders.
Populus deltoides Marsh.
Juglans nigra L.
Ulmus americana L.
Ulmus fulva Mx.
Celtis occidentalis Mx.
Morus rubra L.
Gleditschia triacanthos L.
Gymocladus dioica (L.) Koch.
Acer negundo L.
Fraxinus lanceolata Borak.
Quercus macrocarpa Mx.

The shrubs and lianas are identical with those at the mouth of Mulberry creek. The only peculiar species, therefore, is the Burr oak. The Burr oak, coffee-bean and Black walnut extend up the creek for several miles, about one-third the distance of the wooded part. The other trees and shrubs begin to disappear in about the same order as on Mulberry and North creeks.

In the southwestern part of the country there are more of the characteristic Eastern trees, as the sycamore, Prickly ash, Red juniper, hickory, and a number of oaks. In the northeastern corner the buckeye and bladdernut are present. In passing westward through the northern part of the state the forest belts are of the same character as those on the two small creeks under discussion. At Jennings, in Decatur county, I found about the same creek flora. Only about a mile of Prairie Dog creek was studied; so the woody flora may not be quite complete for the region, but the list shows the striking similarity of the two localities, although there is a decided difference in the herbaceous plants. The following woody plants were observed:

TREES.	SHRUBS.
Salix amygdaloides Anders.	Salix fluviatilis Nutt.
Populus deltoides Marsh.	Ribes aureum Pursh.
Ulmus americana L.	Rosa arkansana Porter.
Celtis occidentalis L.	Prunus americana Marsh.
Gleditschia triacanthos L.	Amorpha fruticosa L.
Acer negundo L.	Rhus aromatica Ait.
Fraxinus lanceolata Borak.	Symphoricarpos occidentalis Hook.

LIANAS.

Vitis vulpina L.

The upland of Clay county is not adapted to tree growth naturally. The prairie is a true climatic prairie. Trees like the cottonwood frequently die in about twenty years on the high upland if left to themselves. Box-elders and Black walnut also will not thrive. But in ravines and in creeks and river-bottoms conditions are favorable for abundant tree development if once a stand is secured and the ground is not pastured or burned over by prairie fires. But, because of the prevalence of fires, up to thirty years ago the bottoms were not covered by a forest, except narrow and usually interrupted and comparatively short-lived belts along the banks of the streams. Since the forest belts could not progress outward into the prairie, they were as continually cut away by the meandering of the streams as they were developed. At the present time the timber belts along both the rivers and creeks are progressing outward wherever natural conditions prevail. The writer knows

personally of many forest belts which have traveled outward for a considerable distance in the last twenty years. The same is true of the development of wooded bluffs.

The origin of the different types of forest belts and patches may be considered under the following heads: (1) The river-bottom; (2) the creek bottom; (3) the wooded bluff; (4) the ravine.

The River-bottom.—The main development of forest in the river valley is along advancing sand-bars. On the inner side of the river bends the low bar is often overflowed and covered with a rich sediment. On the edge of the bar, above the river-bed proper, there usually grows up a belt of Sand-bar willow (*Salix fluviatilis*) which often travels forward at about the same rate as the bar advances. The roots of this willow spread out beneath the surface of the sand and send out numerous shoots, so that a very close thicket is formed. The Sand-bar willow soon dies, but in the meantime it is replaced by the Peach-leaf willow, and finally by the cottonwood. The cottonwood forest is the normal river-bend forest, and is gradually replaced by the other trees of the river valley which form the culmination flood-plain forest of the region. These trees are as follows: Black walnut, White and Slippery elm, hackberry, Red mulberry, redbud, coffee-bean, Honey-locust, and Green ash. In an old forest which has gone through the normal development, the trees enumerated above make up the bulk of the individuals, with here and there an isolated giant cottonwood, which has escaped destruction.

Sand-hills and ridges blown up by the wind support but a thin stand of grass and other herbs, and in the blowouts and on the newly formed ridges several shrubs, which are forest forerunners, gain a foothold. The most important shrubs are *Prunus watsoni* and *Prunus americana*. Usually the first trees to come in are Honey-locusts, coffee-beans, and, in the deep blowouts, cottonwoods.

Ravines opening into low river-bottoms sometimes lose their channel before reaching the stream, and the soil thus covered with sediment gives rise to a moist-ground forest. The first important trees and shrubs are Sand-bar willow, Peach-leaf willow, and in the lower places *Cephalanthus*. Finally White Elm, Green ash, Black walnut and other trees take possession, and a normal forest is produced.

Cut-off river meanders also frequently give rise to forests. The old channel is gradually filled up with mud and sand, and, where

water is absent, willows, cottonwoods and other trees soon take possession of the river-bed and its banks.

The river-bottoms are inhabited by great numbers of gophers. These throw up small mounds of earth, sometimes several yards in diameter. Here seeds of trees sprout and a forest results. Formerly the fire prevented much development of this type of forest. But at present gopher hills are a very important factor in the out extension of the forest belts. The Green ash is most aggressive in taking possession of these hills. Rough-leaf dogwood is also important. I know of a number of young forests which have developed in this way since prairie fires have ceased. During the regions of the fires the Green ash could be found far out in the prairie occupying the isolated gopher hills, but burned down so as form a sort of woody crown-former.

The Creek Bottom.—Along the smaller creeks there is usually only a narrow belt of forest on both banks, extending from the water up to the flood-plain level. The presence of this forest is due to the moist condition of the creek bank and the layer of alluvium which is deposited at each ordinary rise of the water. The alluvium not only covers the grass and other herbs but gives a very favorable soil for the development of woody seedlings. Where there are sharp bends small, low bars are formed, subject to frequent overflow, and these are covered by a forest of the type in the river valley on a smaller scale. The succession of trees is however not the same. The important tree is the box-elder, which takes the place of the cottonwood along the river. The forest may also extend outward on gopher hills, and the Green ash, so far as it extends up the creek, is the main tree to take possession. The outward extension in the creek bottoms is very marked since prairie fires have ceased. Some low, narrow flood-plains may be entirely wooded, but this is exceptional at present.

The creek-bank forest is continually progressing up stream, and this extension is now very rapid because of the large amount of sediment brought down from plowed ground. On Mulberry creek, near the upper limit of the timber belt, the alluvium was very abundant and covered with a luxuriant growth of large weeds. The beginnings of a forest were shown by the presence of large numbers of young trees of box-elders, cottonwood, and Peach-leaf willow.

The Wooded Bluff.—The steep bluffs along the river, creeks and larger ravines furnish another physiographic form favorable for forest development. The bluffs most completely wooded face the

north. The south-facing bluffs are usually too dry for forest growth. After the slope is of sufficient steepness much wash accumulates toward the base and affords protection for young trees from fire and a good soil for seedlings to develop. Because of shade, slowness of evaporation, and safety from fire, the steep north-sloping bluff often supports a small growth of trees even where the creek bank is barely beginning to harbor isolated thickets and the first young pioneers among the trees. The trees of the wooded bluffs are mostly hackberry, White elm, wild plum, Rough-leaf dogwood, Smooth sumac, and Choke-cherry, with a number of smaller shrubs and lianas.

The Ravine.—The ravine valleys are usually so narrow that fires were very destructive, and formerly they contained little besides small thickets of *Amorpha fruticosa*, usually confined to the banks of ponds, Sand-bar willow, elderberry, Smooth sumac, and Poison ivy, which usually grew as a sort of crown-former with annual aerial shoots. But at present Peach-leaf willows, cottonwoods, and occasionally White elms, Green ashes, box-elders, and escaped Osage oranges and White mulberries are developing very rapidly, so that where fire and grazing are absent little forest belts are appearing where thirty years ago there was nothing but pure prairie. The abundant sediment deposited from the cultivated fields is probably a very important factor at present in facilitating tree development in the ravines. The steep north-facing bluffs of the larger ravines are often covered with thickets of wild plum, Rough-leaf dogwood, Smooth sumac, gooseberry, coral-berry, and raspberry. Very often, also, Poison ivy and Riverside grape are present, and occasionally a tree.

HELIUM IN KANSAS NATURAL GAS.

By H. P. Cady and D. F. McFarland.

SUMMARY.

FORTY-FOUR gases have been analyzed. Three are from other gas-fields than the Kansas field, the remainder from Kansas and the parts of Missouri and the Indian Territory that are really continuations of the Kansas field.

Helium has been found in every gas examined, in quantities ranging from less than a hundredth of one per cent. to nearly two per cent.

The average quantity of helium in the gases from other fields, which included samples from Indiana, West Virginia, and Ohio (0.135 per cent.), was much less than the average for gases from the Kansas field (0.335 per cent.).

Kansas gases exhibit the widest variation in the quantity of helium. The highest amount found was 1.84 per cent., in the gas from Dexter, in Cowley county, while the lowest was from Paola, in Miami county.

An examination of the geographical location of the various sample shows a remarkable regularity in the distribution of the helium.

If the points which show equal quantities of helium be joined together on the map, it will be seen that the lines follow a general direction of northeast to southwest, and that the lines are roughly parallel. By this means it may be seen that on the eastern side of the field the helium content is very small, nearly all being below 0.10 per cent., the single exception being Olathe gas, which shows 0.40 per cent.

Helium content rises as we go west, reaching a maximum along a line connecting Dexter and Eureka. Then the few samples which could be obtained from the extreme western edge of the field, as at present developed, show a sudden falling-off in the amount of helium. At Arkansas City, only about twenty miles from Dexter, the quantity is only 0.16 per cent. There is a rise from here to the western edge of the field of nearly half a per cent., the sample from Elmdale, the furthest west of all, giving 0.56 per cent.

It is further to be noted that the quantity of nitrogen in the gases rises or falls generally with the quantity of helium, although a strict proportionality has not been found; also, in general, the quantity of combustible constituents in the gas varies inversely

with the quantity of helium and of nitrogen. A gas high in helium is low in methane and other combustibles, and high in nitrogen, while the gas low in helium is high in combustibles and low in nitrogen—a much better gas for heat production. The economic significance of these facts cannot be discussed here, but they have a very important bearing upon the use of the gases for domestic and industrial purposes.

If the lines of equal helium content be compared with the lines of outcropping of the various successive geological strata across the eastern part of the state, a marked similarity is at once noted.

The lines follow almost the same course and indicate a connection between geological structure and distribution of the helium. This relationship will be further inquired into as time permits.

Kansas is to be congratulated on the possession of an unlimited and easily available supply of what has been considered a very rare element, a supply which has never been suspected before. It assures the fact that helium is no longer a rare element, but a very common element, existing in goodly quantity for the uses which are yet to be found for it.

A NOTE ON THE DETECTION OF CYANIDES.

By H. P. CADY, University of Kansas, Lawrence.

THE detection of cyanides in the presence of ferrocyanides, ferricyanides or sulfocyanates is complicated by the fact that most of the tests for the cyanides are not direct tests, but involve the formation of ferrocyanides or sulfocyanates from the cyanides, and, consequently, are not applicable in the presence of the above-mentioned substances.

Since hydrocyanic acid is both a very weak and an easily volatile acid, it would seem that one ought to be able to separate the cyanides from admixture with these other substances by making the solution containing them slightly acid and distilling off the hydrocyanic acid. Any of the well-known tests could then be applied to the distillate. There is this difficulty, however, that ferro, and ferricyanides and sulfocyanates will all yield hydrocyanic acid when an acid solution containing them is distilled at the boiling temperature. Hilger and Tamba state that cyanides may be detected in the presence of ferro- and ferricyanides by acidulating with tartaric acid and passing a current of carbon dioxid through the solution, taking care not to warm the solution above sixty degrees. On account of the restricted conditions this method is not adapted to use by students.

The cyanides are salts of very weak acid, while the ferro- and ferricyanides and sulfocyanates are salts of strong acids; as the result of this, the cyanides are, upon going into solution in water, largely hydrolytically split up with the formation of much free hydrocyanic acid, while the hydroferrocyanic acid, etc., are not formed. As a result of this, hydrocyanic acid will distil from a solution of potassium cyanide although the latter is highly alkaline. The hydrolysis of all salts of weak acids is greater if there is present at the same time in the solution the cations of some weak base; hence the hydrocyanic acid will distil much more readily from the potassium cyanide solution if there be added to the latter some ammonium chlorid.

A very simple separation of the cyanogen ion from the interfering ions may be based upon the above. All that is necessary is to make the solution alkaline with ammonium hydroxid, add some ammonium chlorid, and distil at the boiling temperature. Under these conditions the ferro-ferricyanides and the sulfocyanates are

perfectly stable, while the cyanides readily yield hydrocyanic acid, which may be detected in the distillate through the formation of Prussian blue or by the precipitation of silver cyanide in an acid solution of silver nitrate. The simplest method of all, though, is to place a little of the solution to be tested in a small beaker, add ammonium hydroxid and ammonium chlorid; as before, cover with a small watch-glass carrying on the under side a small piece of paper wet with a one-fourth normal solution of copper ammonia sulfate. The beaker is then slightly warmed and set aside for some time. If cyanides are present the paper will lose its blue color, owing to the change of the copper ammonia ion into the colorless cuperous cyanogen ion. By this means as little as one-tenth of a milligram of potassium cyanide may be detected. In order to get the full delicacy of the test the paper must be small and the action must go on for several hours. In the absence of cyanides, but in the presence of the ferrocyanides, etc., the paper will retain its blue color for days.

NOTE ON MERCUROUS SULFATE FOR STANDARD CELLS.

By H. P. CADY, University of Kansas, Lawrence.

CARHART and Hullet have recently recommended that the mercurous sulfate used in the preparation of Clark or cadmium standard cells be prepared electrolytically by using an anode of pure mercury, a cathode of platinium and sulfuric acid as the electrolyte. The mercurous sulfate prepared in this way is crystalline in character and gives very uniform results when made up into cells. It is, however, somewhat troublesome to make and the process is a rather slow one.

A sample of mercurous sulfate, a so-called C. P. article, which gave cells differing from the true value by nearly a millevolt, was rubbed up with a little mercury and kept on a hot plate under dilute sulfuric acid for some hours. At the end of this treatment the sulfate was crystalline and gave cells which agreed almost exactly with those prepared from the electrolytically prepared sulfate. It is easier to buy mercurous sulfate and purify it by the above process than to prepare it by the electrolysis, and the product seems to be as good.

A PROPOSED TEST FOR BLEACHED FLOUR.

By J. T. WILLARD, Kansas State Agricultural College, Manhattan.

WITHIN the last three years there has been a great development of the artificial bleaching or aging of flour. In this it is claimed that the color of the flour is improved and also its baking qualities, so that the treatment gives flour properties that it would naturally acquire on being stored several months. Although boards of health have taken no action concerning this treatment of flour, manufacturers who have not adopted the process and do not wish to go to the expense are claiming that such flour is unwholesome, and the belief that this is the case is not uncommonly held by consumers. A simple test to distinguish artificially bleached flour is therefore something to be desired.

Inasmuch as the bleaching processes in use employ oxids of nitrogen produced in one way or another, it occurred to the writer that Griess's test for nitric acid by means of alphanaphthylamine and sulfanilic acid might be available. In applying this test we have used the modification suggested by Ilosvay, who uses acetic acid instead of mineral acid. One-half gram of sulfanilic acid is dissolved by heat in 150 cubic centimeters of dilute acetic acid. One-tenth gram of alphanaphthylamine is heated with 20 cubic centimeters of strong acetic acid, and the colorless solution poured off from the residue and mixed with 130 cubic centimeters of dilute acetic acid. For use, the two solutions are mixed in equal quantities and two cubic centimeters of the mixed solution added to the liquid to be tested.

In testing flour, about a teaspoonful is shaken with a few cubic centimeters of distilled water and the reagent added directly to it. A pink color of varying intensity is obtained with bleached flour in a few minutes, while unbleached flour gives no reaction. The delicacy of the test is increased by settling out the flour by the use of the centrifuge.

This test, as will be seen, is very speedy. Its applicability, however, is not yet fully determined, as nitrites are subject to oxidation, and possibly other chemical changes might take place with the lapse of time that would cause failure to react for nitrites. The matter is under further investigation touching this point.

ON SOME FERROCYANIDES OF CALCIUM, BARIUM, AND MAGNESIUM.

By F. B. DAINS, Washburn College, Topeka.

WHEN potassium ferrocyanide is added to solutions of calcium, barium and magnesium containing free ammonia or ammonium salts, difficultly soluble precipitates are obtained. Concerning the composition of these precipitates some confusion seems to have arisen. The general idea has been that they were double ferrocyanides of potassium and the alkaline earth metal. Tests, however, showed that the product always contained ammonia; hence it seemed of interest to ascertain whether the precipitate was a definite chemical compound or a mixture of ferrocyanides.

H. Baubigny, in an article on the separation of calcium, barium, and strontium (Chem. News, 72, 27), suggests that after the removal of the barium as barium chromate, and after getting rid of the excess of the chromate, the calcium be precipitated by means of potassium ferrocyanide in ammonium chlorid solution. On the authority of Rose, he calls this precipitate a potassium-calcium ferrocyanide. He also recommends the use of potassium ferrocyanide as a test for calcium.

In the text-book of qualitative analysis by Bailey and Cady (first edition) the precipitation of calcium and magnesium by potassium ferrocyanide in the presence of ammonuium salts is mentioned, and the fact pointed out that they contain ammonia. Recently (Jour. Am. Chem. Soc., 28, 1510) Flanders has suggested the use of potassium ferrocyanide in the presence of ammonium chlorid as a test for calcium, and on the authority of Prescott and Johnson (1903, p. 212) calls the precipitate potassium ferrocyanide.

EXPERIMENTAL.

The product formed by precipitating a calcium salt with potassium ferrocyanide in the presence of a large excess of ammonium chlorid or nitrate was thoroughly washed with hot water, and dried, first on a porous plate, and then at seventy degrees in an oven. Qualitative tests showed that the product contained potassium, ammonium, calcium, the ferrocyanogen ion, and water. Analysis of various preparations gave results which correspond to the folowing formula: $K_2CaFe(CN)_6$, $4(NH_4)CaFe(CN)_6 2H_2O$.

	Found.	*Calculated.*
NH	9.62	9.49
K	5.10	5.15
Ca	13.18	13.19
Fe	18.48	18.39
H_2O	2.24	2.37

When potassium ferrocyanide is added to a barium salt under similar conditions, a light yellow, heavy, granular precipitate falls, which is soluble enough in hot water so as to admit of crystallization from that solvent. This fact was known to Thenard, since he suggests the separation of barium from strontium by precipitating the barium in ammonia solution by means of potassium chromate. (Children's translation of Thenard's Essey on Chemical Analysis, 1819, p. 123). The analysis of the material, air-dried on a porous plate, gave results corresponding to the formula $K_2BaFe(CN)_6$, $4(NH_4)BaFe(CN)_6 15H_2O$.

	Found.	*Calculated.*
K	3.55	3.49
NH_4	6.76	6.44
Ba	30.46	30.67
Fe	12.53	12.48
H_2O	11.80	12.06

Magnesium salts under these same conditions give a fine white precipitate, difficultly soluble in water and acids. In Watts's Dictionary, edition of 1869, a ferrocyanide of magnesium and ammonium is mentioned as having been obtained, but in an impure state. The cause of this lies in the carrying down of a slight excess of magnesium, probably due to the formation of a small amount of $Mg_2Fe(CN)_6$. The product carefully washed and air-dried to constant weight gave figures which correspond best to this formula: $K_2MgFe(CN)_6$, $5(NH_4)MgFe(CN)_6 10H_2O$.

	Found.	*Calculated.*
Ka	3.85	4.22
NH_4	9.79	9.72
Mg	8.43	7.87
Fe	17.96	18.06
H_2O	9.94	9.70

DETERMINATION AND COMPARISON OF SOUND INTENSITIES.

By Bruce V. Hill, University of Kansas, Lawrence.

WE are now able to compare the power and efficiency of different luminants with considerable ease. For similar measurements dealing with the energy from sounding bodies we have, however, at present no method. Several properties of the vibrations and waves concerned in the two cases, as well as the peculiarities of the sense-organs involved, are responsible for this. To compare the illumination power of two lamps, the common procedure is either to produce equal illumination from the two sources on adjacent parts of the same screen, or so to adjust the two that shadows, of equal depth are cast. Now, both of these methods depend upon the fact that light travels very nearly in straight lines. Sound waves, having so much greater wave length, do not even approximate rectilinear propagation.

The eye is very sensitive to changer of intensity, but not to small shadings of color. With the ear the reverse is true. Very small changes of pitch can be perceived, while variation of loudness is required to make itself noticed. A lamp varying even slowly is unpleasant, while, in music, the accent and shading are necessary, and so by habit we are less able to discriminate slight changes of sound intensity. Again, the ear has a power of analysis which the eye does not possess. A white light may really be made up of a number of different combinations of colors. In the sound from a number of instruments, however, the ear can pick out, not only the separate pieces, but the overtones given by them, amounting in all to hundreds.

All these things make it impossible to compare tone intensities as we do those of light. The effect of a given source of light might be measured by its chemical action, but, so far as we know, there is no corresponding effect due to sound. There are several effects produced by sound, and of these we will speak briefly, and give a short account of the attempts to solve the problems of sound-intensity measurement. The action of the microphone has long been known. If in the circuit with a battery and a telephone receiver is placed a carbon rod, resting loosely upon carbon supports at its ends, a very slight jar varies the resistance of the contacts and causes a sound in the receiver. Three nails in H shape make

a fairly sensitive microphone. The ordinary transmitter is a device on the same principle. A number of years ago Wm. Weber suggested the use of the variable current thus produced as a measure of sound intensity. The currents in the secondary circuit of a local battery telephone set are so exceedingly small, however, that there has until recently been no reliable instrument to measure them, though several have been proposed. Even now it is not certain that the instruments suggested for this purpose will be successful. This method will be touched upon later.

In 1878 and 1881 Vierordt published several papers in which he describes methods of comparing sound intensities by the distances to which they were audible. He found that the law of inverse squares does not hold as in the case of light, but that the intensity decreases as the inverse first power of the distance. Here he depends upon the ear, which is very unreliable, especially at the *threshhold of sensation.* Rayleigh has found that, under certain circumstances, no relation seems to exist between the intensity of the stimulus and that of the resulting sensation. Certainly the ear is much more sensitive to sounds of some pitches than to others. Even if the method of Vierordt were trustworthy it could not well be used, as considerable space must be had out of doors, and quiet.

Next in the point of time came the suggestion of Overbeck. He used a microphone with but two carbon contacts, the one resting lightly on the other and the whole upon a resonance board. He showed that, to a certain degree of approximation, the increase of the resistance of this arrangement, when acted upon by a sound vibration, was proportional to the intensity of the sound falling upon it. It was therefore put into one arm of Wheatstone's bridge, a balance obtained when the microphone was at rest, and the deflection of the galvanometer produced by a sound wave falling upon the apparatus measured. This was useful only for sounds of moderate intensity and for the range of pitch c to c′.

Dvorak describes a number of contrivances depending upon the repulsion of resonators and of light aluminum vanes perforated with holes larger on the one side than on the other. In a similar way Professor Wood, of Baltimore, has made a sound pedometer, the speed of which depends upon the intensity of the tone, but which cannot be used as a measure of it. Lord Rayleigh suggested placing a light mica vane within a tube at an angle of forty-five degrees to the axis of the tube. At the open end of the tube was an elastic diaphragm at the node of a standing wave of the sound to be studied. When the sounding body was in action the vane tended

to set itself along the axis of the tube. This motion was balanced by the action of a magnet upon the vane and held in position by the field of the earth. E. Grimsehl used a similar arrangement.

None of the methods so far described, however, with the exception of that of Weber, is of more than incidental interest. All depend upon assumptions and have very limited possibilities. Prof. Max Wien, in 1889, constructed his *optical telephone.* Upon the diaphragm of a special receiver he placed a small mirror which vibrated with the varying current in the magnet spools, thus giving a measure of the amplitude of the vibration of the diaphragm. Later, he placed the mirror directly upon a membrane actuated by the vibration to be studied, without the intervention of the telephone. If the tone under consideration is *pure*, that is, if it can be represented by a simple sine function, the intensity in absolute measure may be calculated from the amplitude thus found. For complex tones, and those with which we have most to do are very complex, this method is of no direct value.

G. Stern, in 1891, used a special microphone to study the intensity of sound in the various parts of a room. The method is merely qualitative and gives us little of any value.

Mr. B. F. Sharpe, working with Professor Webster, at Clark University, estimated the intensity of sound as follows: One total reflecting mirror of a Michelson refractometer is made small and light and mounted upon a thin plate forming part of the wall of a Helmholtz resonator. The objective of the observing telescope was a lens mounted upon one prong of a tuning-fork of the same period as the tone to be studied. A system of oblique bands was formed, the inclination of which is a function of the intensity of the sound. Here also the method is inapplicable to anything but a pure tone.

As shown mathematically by Rayleigh, radiation must exert a steady pressure upon a surface that opposes its advance. Nichols and Hull demonstrated the existence of this pressure in the case of light several years ago. More recently Altberg constructed an apparatus consisting of a reflecting wall in which there was a circular hole. Within this hole was a plunger supported upon one arm of a torsion balance. In this way he succeeded in measuring the actual energy given out by a glass tube set in longitudinal vibration by the friction of a rapidly rotating rubber of cloth wet with alcohol. With a sound so loud that he was obliged to stop his ears while working with it he found a radiation pressure of 0.25 dynes cm^2. If this method could be applied to sounds of ordinary intensity it would certainly be very valuable, but this noise was prob-

ably hundreds of times more intense than those with which we ordinarily have to do. When working with light the suspended parts could be put within an air-tight vessel and so protected from air currents, but in the case of sound measurements this is impossible, as that would shut off the pressure that we desire to measure. This puts a very definite limit to the delicacy of the suspended system that may be used in such an instrument. Some form of microphone, properly calibrated, will perhaps prove in the end the most satisfactory means of estimating sound intensities.

III.

GEOLOGICAL PAPERS.

"SOME GEOLOGICAL STUDIES ON NORTHWESTERN WASHINGTON AND THE ADJACENT BRITISH TERRITORY."

By ALBERT B. REAGAN, Mora, Wash.

"SOME ANIMALS DISCOVERED IN THE FOSSIL BEDS OF KANSAS."

By CHARLES H. STERNBERG, Lawrence, Kan.

SOME GEOLOGICAL STUDIES ON NORTHWESTERN WASHINGTON AND ADJACENT BRITISH TERRITORY.

By ALBERT B. REAGAN, Mora, Wash.

THE region under consideration extends in a north and south direction from the city of Bellingham north to the Fraser river in British Columbia; and in an east and west direction from the foot-hills of the Sumas and Selkirk mountains to Georgian Bay. For the most part its practically low, level surface consists of estuary and glacial deposits, some trap and granite rock, and a small patch of Eocene exposed in British Columbia and a larger patch of Eocene at Bellingham. The whole region was once heavily timbered, but now, on the southern side of the international boundary-line, it is about half cleared and the other part might be termed "logged off" lands, as the best timber has been cut. And now railways and wagon roads traverse it in all directions. The area in British Columbia is still in the virgin state, with the exceptions of a few clearings here and there. In the Fraser delta, however, there are large areas of cleared land. At places it is thickly settled. Also large cities are on the river here. The cleared lands are valued at from $60 to $120 per acre; the "logged off" lands on the American side, $10 per acre. The region is a difficult one in which to trace out geological formations in detail. Only a reconnoisance trip was made in British territory.

LITERATURE.

In volume I of the Washington Geological Survey, Prof. Henry Landes, state geologist, describes the region in the vicinity of Bellingham, giving the resources of the same in detail. A further mention of his work will be given when the subjects concerned are considered.

STRATIGRAPHICAL SECTIONS.

1. Section at the water's edge one-half mile south of Fish Point:

1. Dark brown sand, containing layers of oyster shells, which seem to indicate that the deposit had evidently been at least a tide-water beach. ..... 1 foot.
2. Light brown sand tinged occasionally with ocher.....10 feet.
3. Blue ground moraine clay, containing small water-worn granite fragments, also large granite boulders of glacial origin, as is demonstrated by parallel scratches and by one face of the boulders being flattened.....14 "

2. Section on Bellingham bay, one and one-half miles south of Fish Point:

1. Black earth ..... 6 feet.
2. Yellow clay, containing round fragments ..... 8 "
3. Sand ..... 10 "
4. Coarse gravel, cobblestones, and sand—an occasional large boulder—all promiscuously mixed, apparently outwash material at the foot of the glacier. Occasional sorting is shown ..... 20 feet.

3. Section 300 feet south of section 2:

1. Alluvium ..... 4 feet.
2. Yellow clay and sand ..... 14 "
3. Very coarse gravel, containing many cobblestones ..... 10 "
4. Banded coarse sand ..... 16 "

4. Section 300 feet south of section 3:

1. Alluvium ..... 4 feet.
2. Yellow sand ..... 10 "
3. Gravelly sand ..... 10 "
4. Laminated coarse sand ..... 14 "
5. Coarse gravel ..... 4 "
6. Light brown, massive, very fine sand ..... 3 "

5. Section 300 feet south of section 4:

1. Alluvium ..... 4 feet.
2. Yellow sand ..... 14 "
3. Light brown, fine sand ..... 10 inches.
4. Coarse, laminated sand, with laminæ dipping south 45 degrees ..... 16 feet.
5. Coarse, laminated sand ..... 8 inches.
6. Coarse gravel, bedded, with beds dipping south at an angle of 45 degrees ..... 4 feet.
7. Not seen ..... 4 "

6. Section 600 feet south of section 5:

1. Alluvium ..... 4 feet.
2. Yellow sand ..... 14 "
3. Massive dark brown sand, containing rounded and angular fragments ..... 28 "

7. Section 300 yards south of section 6:

1. Sand ..... 10 feet.
2. Blue clay, containing large boulders. In this stratum there are *Pecten* and other marine shells ..... 30 "

8. Section 600 feet south of section 7:

1. Yellow sand ..... 20 feet.
2. Laminated blue clay ..... 2 "
3. Massive blue clay (*Pecten* shells) ..... 2 "

Sections 2–8 are extraglacial deposits of the narrow moraine

delta type. They were apparently deposited at the mouth of an osar stream.

In section 5, opposite the mouth of the above glacial stream a glacial foot maintained itself for a considerable time. Later it was pushed further south. That the terminal moraine was at this point is attested by the numerous large boulders in the debris.

9. Section in well at Marietta:

1.	Sand and gravel	10 feet.
2.	Sand containing marine shells	2 "

10. Section 300 yards west of the portage on Hale's Passage:

1.	Soil	1 foot.
2.	Alternating strata of gravel and sand, the strata dipping in the bedding both east and west of the point where the section was taken	16 feet.
3.	Unstratified sand, containing boulders from the size of a pebble to a hundred tons weight	8 "
4.	Very light brown, very finely laminated, promiscuously bedded sand, having a wedge of gravel embedded in it. This sand was seen to pinch out in a short distance both to the east and to the west of the point where the section was taken,	6 inches.
5.	Gravel	2 "
6.	Very light brown sand	1 "
7.	Gravel and light gray, coarse sand, stratified, the striæ being wavy	1 foot.
8.	Laminated, fine, light brown sand, the laminæ very wavy and irregular	1 "
9.	Stratified sand, carrying cobblestones	1 "

11. Section on Bellingham bay, just east of Louis Tsetsatin's house, at the bridge, in section 36 of the Lummi reservation:

1.	Unstratified sand	7 feet.
2.	Blue clay, containing pebbles	6 "

12. Section in well one-fourth mile east of Mountain View:

1.	Clay and sand	14 feet.
2.	Stratum containing sea-shells	2 "

13. Section in Mr. F. C. Reeve's well, two miles east of Birch bay:

1.	Soil	2 feet.
2.	Yellow clay	20 "
3.	Bluish yellow clay	2 "

14. Section in Mr. Chambers's well, one mile east of Birch bay:

1.	White to yellow clay, containing pebbles and boulders	14 feet.
2.	Blue clay, containing sea-shells	6 "

15. Section in well one mile northeast of Birch bay:

1.	Gravelly soil	1 foot
2.	Gravelly subsoil	2 feet
3.	Blue clay	20 "
4.	Beach deposits, containing clam-shells	1 foot

The water in this well is brackish.

16. Section on bluff opposite the railway curve on Semiahm[illegible] o[illegible] bay, near Main street, in Blaine:

1.	Light brown sand, a sand-plain deposit of the Blaine esker	15 feet
2.	Yellow clay	8 "
3.	Light blue clay	8 "

17. Section in a well opposite the schoolhouse in section [illegible] township 40, range 1 east:

1.	Clay	14 feet
2.	Sea-beach gravel, containing boulders and marine clam-shells,	8 "

18. Section in a well in the northeast corner of section 18, tow[illegible] ship 40, range 1 east:

1.	Mostly quicksand. (The water of the well is brackish and has an iron-rust taste. It is poor boiler water)	10 feet

19. Section in a well in British Columbia, one-fourth mile nor[illegible] t[illegible] of the northeast corner of section 35, township 40, range 2 east, [illegible] i[illegible] the United States:

1.	Clay	55 feet.
2.	Sand and gravel, containing sea-shells	5 "

20. Section in Mr. Waker's well in British Columbia, near t[illegible] e boundary line of section 31, township 40, range 3 east, in t[illegible] e United States:

1.	Clay	45 feet.
2.	Sand (cottonwood brush; sea-shells)	5 "

21. Section on the road six miles west of Abbott's Ford, Briti[illegible] h Columbia:

1.	Soil	1 foot.
2.	Stream-wash gravel	4 feet.
3.	Blue sand, coarse enough for plastering purposes	3 "
4.	Fine yellow sand	3 inche[illegible]
5.	Same as 3	4 "
6.	Same as 4	16 "
7.	Same as 3	6 "
8.	Fine yellow sand	4 "
9.	Blue sand, same as 3	4 "
10.	Minutely laminated fine white sand	4 feet.

22. Section 200 feet east of the last section:

1.	Gravel containing boulders	4 feet.
2.	Greenish, plaster sand	4 "
3.	Fine gravel	2 "

23. Section on the road 100 yards southeast of Abbott's Ford, British Columbia:

1.	Brownish red soil	3 feet.
2.	Sand containing cobblestones	12 "
3.	Cross-bedded coarse sand, containing gravel lenses	4 "
4.	Sand and gravel	5 "

24. Section on the road one mile northwest of Sumas lake (Eocene):

1.	Not seen	300 feet.
2.	Blue shale	10 "
3.	Lignite	2 "
4.	Dark shale	18 "
5.	Lignite	6 inches.
6.	Dark blue shale	20 feet.
7.	Yellowish, rather massive sandstone	100 "

Parties have tried to mine coal here at several different times; but the seams are too thin and there is too much dirt in the coal to make it pay.

25. Section four miles south of Murphy's Landing, on the Fraser (Eocene):

1.	Sandstone, shale, fire-clay, and very small seams of lignite (estimated)	500 feet.

26. Section just west of the railway-tracks at Sumas City:

1.	Sand and gravel	42 feet.
2.	Sandy gravel	40 "
3.	Sand	20 "

27. Section in a well in the southwest quarter of township 40, range 4 east:

1.	Light, sandy yellow clay	8 feet.
2.	Quicksand	4 "

28. Section on the road two and one-half miles east of Everson:

1.	Soil	3 feet.
2.	Coarse gravel	10 "
3.	Fine gravel	12 "
4.	Plastering sand	2 "

29. Section in road cut on the Bellingham northeast diagonal road, one mile south of Lawrence post-office:

1. Sandy soil	2	feet.
2. Sand	10	"
3. Blue to yellow clay	15	"
4. Blue clay	20	"

30. Section on the Bellingham road two miles southwest of Lawrence post-office:

1. Soft blue clay	27	feet.

This clay has been tested and is said to be a good potter's clay. It is also said to be a good brick clay. In quantity it is almost inexhaustible.

At the base of this clay, 100 feet from the surface, in East Rome, near Lawrence post-office, gas was struck; but it was not in paying quantities.

FORMATIONS IN DETAIL.

TRAP.—A trap-rock dike was found running in an east and west direction from near Abbott's Ford, British Columbia, to Sumas lake. It is composed of schist and serpentine rock, through which a ridge runs carrying gold, from fifty cents to a dollar and a half per ton. The height of the dike ridge is 500 feet (estimated).

GRANITE.—A patch of granite fills the triangle between the Sumas and Fraser rivers at their confluence. This area, which was examined only in a very general way, was found to contain iron-ore beds, the extent of which is yet undetermined.

EOCENE-MIOCENE (marked Eocene on the map).—This formation is composed of light bluish gray to light buff sandstones and light gray to black carbonaceous shales, grading into seams of more or less impure coal. The measured thickness, according to Mr. Bailey Willis,[1] is 10,000 feet. The formation is much broken. Some earth blocks of it are raised to a high altitude, with the strata still practically horizontal, an example being the greater part of the Eocene area mapped in British Columbia; other earth blocks are pitched at a high angle, sometimes reaching or exceeding even ninety degrees. The formation seems to be of lake origin, the coal-measures of Eocene age; the series above the coal, Miocene. Prof. F. H. Knowlton, of the United States Geological Survey, after correlating the fossils of this formation, places its age as somewhere near the Middle Tertiary.[2] For a more detailed de-

1. Geological Survey of Washington, vol. I. part IV, p. 44.

2. Preliminary Report on Fossil Plants from the State of Washington, collected by Henry Landes, 1901.

scription of this formation, see Eocene Epoch[3] and Geology of the Coal-measures of Washington.[4]

PLIOCENE.—A conglomerate rock was found in a little valley about four miles south of Murphy's Landing, on the Fraser river. A much larger area of the same kind of rock was found on the foot-hills just north of the Sumas mountains. It is undoubtedly much later in age than the Eocene-Miocene of the same region, because in British Columbia it fills a chasm left by the faulting of that formation. As no fossils were found, its age could not be determined. Its horizon, however, would seem to place it in the Pliocene.

GLACIAL.—The glacial deposits, which exceed 500 feet in thickness, are the surface rock of the entire region from the foot-hills to Georgian Bay, except where they are covered with recent deposits. They were deposited in the then Georgian Bay from the Mt. Baker and British Columbia glaciers. At the culmination of glacial times these two glaciers seem to have been one continuous ice-sheet thousands of feet thick which extended south probably to the Olympic mountains and westward to the Pacific;* but, as the epoch began to wane, they became separated and acted independently of each other. The Mt. Baker or Nooksack glacier then seems to have followed about the course of the Nooksack river to Lynden, and would have continued its course in a northwestern direction if it had not encountered the foot of the northern ice-sheet. This turned it in its course from a northwest to a southwest direction, causing a push-medial moraine, now a ridge, to be formed where the two glaciers came in contact, and a dump-terminal moraine from Blaine south to the portage along the Georgian Bay coast. The Fraser glacier at this time was stopped in its southern advance and turned westward by the granite trap and Eocene highlands in British Columbia, and further deflected westward by the Mt. Baker glacier. Its final dump moraine was probably in Georgian Bay, to the west of the present coast-line. On their final retreat from the region these two glaciers left elevated areas where their push-medial, terminal and lateral moraines had been; and estuaries or sounds between these and the foot-hills, all the country but the morainic strips being at or below sea-level. These strips are typically glacial, and present practically all the phenomena peculiar to a glacial region.

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3. Landes, Washington Geological Survey, vol. I, part I, p. 29.

4. Loc. cit., part IV, p. 43.

*This glacier passed over Orchis island, which is 1800 feet in height, the glacier stripping the island of practically all its soil.

SUBGLACIAL TILL.—This is a gray, blue or black clay. It is very hard, and when dry shows a joint structure. In many places it is a gumbo. At places where it is the surface rock it is very poor soil. It is of great thickness, and underlies the entire region to the foot-hills. It was deposited in sea-water, as its marine shells attest.

FOSSILS FROM THE SUBGLACIAL TILL.—The fossils figured and described here were taken from the subglacial till one mile below Fish Point, on the Bellingham Beach side of the Lummi Indian reservation.

Leda fossa (BAIRD). Figures 1*a* and 1*b*.

"Shell small, elongate, convex, thin; umbones anterior, turning[5] slightly toward the posterior end, which is elongated, narrow, and truncated; anterior end short and evenly rounded; sculpture nearly obsolete, a few concentric lines discernible; escutcheon long, narrow, smooth, and deep-set; an elongate process on middle of interior of posterior end; hinge with small internal cartilage pit, and numerous sharp teeth on each side."

Dimensions: Length, 15 mm.; alt., 8.5 mm.; diam., 5 mm.; umbo to posterior end, 10 mm.; to anterior end, 7 mm.

Distinguishable by lack of sculpture.

Living: Puget sound (Carpenter).

Pleistocene: San Pedro, Cal. (Arnold).

Leda hamata (CARPENTER). Figures 2*a* and 2*b*.

Shell similar to to *L. fossa*, except its surface is sculptured by strong concentric, raised lines; a raised band, strongly transversely sculptured by continuations of the concentric ridges, passes from the umbo around the escutcheon to the posterior end; escutcheon deep-set, smooth.

Dimensions: Length, 11 mm.; alt., 6 mm.; diam., 4 mm.; umbo to posterior end, 7.5 mm.; to anterior end, 5 mm.

Living: Santa Barbara to Catalina, Cal. (Carpenter).

Pleistocene: San Pedro and San Diego, Cal. (Arnold).

Pliocene: Deadman island, San Pedro, Cal. (Arnold).

Leda tenuisulcata (STIMP.) Figure 3.

Shell small, thin, elongate-triagonal, convex, somewhat inflated; umbones anterior, turning slightly toward the posterior end; shell rounded before, much elongated behind, the posterior length about twice the anterior. It is furnished with very fine, distinct, con-

5. Ralph Arnold's description; California Academy of Science, vol. III, p. 96.

centric striæ. A raised area, transversely sculptured by continuations of the concentric striæ, passes posteriorly on either side of the escutcheon from the umbones to the posterior margin of the shell. Both the anterior and posterior teeth are bent, the angle of each being directed toward the beak. Margin entire; cavity of shell rather deep. On the interior of the posterior end is an elongated, somewhat arrow-head shaped, raised process. The escutcheon is smooth.

Dimensions: Length, 6 mm.; height, 3 mm.; umbo to posterior end, 4 mm.; to anterior end, 2 mm.

Pecten (Chlamys) jordani (ARNOLD). Figure 4*a*.

Arnold's description:[6] "Shell of medium size, shape of *P. hericeus*, inequivalve, rather thin; right valve with twenty-five to thirty angular, smooth-topped, imbricated ribs, which become dichotomous after reaching a length of about 30 mm.; interspaces deeply channeled and narrower than the ribs; anterior ear imperfectly radially ribbed with six ridges, and showing elevated, concentric, incremental lines; posterior ear nearly obsolete, showing four ribs; byssal notch not deep; left valve shows twenty-five to thirty narrow, convex ribs, showing imbrications only slightly; interspaces as large as ribs; after a diameter of about 30 mm. has been reached by the shell, small riblets appear in the widening interspaces; anterior ear shows five narrow imbricated ridges, with wide interspaces; both valves show a tendency to contract suddenly at the basal margin upon nearing a completion of growth; surface of both valves covered with a minute, lattice-like sculpture which is generally worn off on exposed portions of the shell.

"Allied to *P. opuntia* (Dall.), but having fewer ribs on disk and ear, and having dichotomous ribs after reaching a diameter of 35 mm. Distinguished from *P. hericeus* and *P. hastatus* by not having fasciculated nor spinose ribs."

Pleistocene: San Pedro and Santa Barbara, Cal. (Arnold).

Pliocene: San Pedro and Santa Barbara, Deadman island, and Packard's Hill, Cal. (Arnold).

Dimensions: Length, 42 mm.; alt., 48 mm.

Pecten rubidos (HDS.) (?) Figures 5*a*, 5*b*, and 5*c*.

Shell of medium size; right valve with twenty-five to thirty broad, smooth-topped, very prominent imbricated ribs which become dichotomous after reaching a length of 45 mm. and also just before reaching the ventral margin; interspaces deeply channeled

6. Loc. Cit., p. III.

and narrower than the ribs; surface of shell covered with a minute latticework where not worn off, also by conspicuous growth lines near the margin; anterior ear imperfectly ribbed with four to six ridges, and showing elevated, concentric transverse ridges and incremental lines; posterior ear small, showing four ribs and conspicuous incremental lines; left valve not seen.

This shell differs from *P.* (*Chlamys*) *jordani* in that the shell is larger and thicker, that its length and altitude are not the same, and that the ribs of the right valve, the valve seen, do not become dichotomous till they are about 45 mm. in length.

Dimensions: Length, 55 mm.; alt., 55 mm. (measure of 5*b*).

Septifer bifercatus (?). Figure 6.

The specimen given here is a fragment of the left valve. By a careful comparison with identified specimens it was doubtfully classed as above. Beds of these shells were found, but on account of their long interment they all crumbled to dust on exposure to the air. This fragment was saved with the greatest difficulty.

Tapes staminea (CONRAD). Figure 7.

Arnold's description:[7] "Shell of medium size and thickness, suboval, convex; surface sculptured with numerous crowded, rounded, radiating ridges and concentric lines, which are most prominent on the anterior end; no lunule; margin sometimes crenulated; hinge narrow; ligament narrow, long; three teeth in each valve; posterior two in right valve and middle one in left valve bifed; pallial sinus long, rounded; muscle impressions not sunken.

"This is a variable species; the shape of the shell and the sculpture varying in different individuals . . . "

Dimensions: Length, 20 mm.; alt., 14 mm.

Living: Straits of Fuca to Lower California (Cooper).

Pleistocene: Santa Barbara to San Diego, Cal. (Cooper); San Pedro, San Diego, Cal. (Arnold).

Pliocene: Santa Rosa; Twelve Mile House, San Mateo county, Kirker's Pass, Contra Costa county, Monterey and San Fernando, Cal. (Cooper); San Diego, Cal. (Arnold).

Miocene: West of San Jose; Foxin's, Santa Barbara county, California (Cooper).

7. Loc. cit., p. 150.

Cardium nuttallii (MART.) Figures 8*a* and 8*b*.

Shell medium size, cordate, inflated, equivalve; each valve with twenty-five to thirty angular imbricated ribs which seem to have been continuous from beak to dorsal margin (the surface of the shells obtained are much worn); interspaces wider than the ribs; surface marked with numerous transverse lines of growth; beaks prominent; abductor scars subequal, pallial line entire.

Dimensions: Length, 36 mm.; alt., 36 mm.

Living: Puget sound; Georgian Bay.

(?) **Abra** (?). Figure 9*a*.

The teeth, pallial line and muscular impressions having been removed from this shell, has made it impossible to identify it definitely.

Macoma nasuta (CONRAD). Figures 10*a* and 10*b*.

Arnold's description:[8] "Shell of medium size, ovate compressed, thin; anterior side dilated; posterior side cuneiform, extremity much above line of base; posterior dorsal margin straight to angle where it joins line of truncation; fold carinated on right valve; umbone slightly anterior to center, slightly prominent, narrow cardinal teeth in each valve; no laterals, ligament external, long, straight, narrow; pallial sinus large, expanding interiorly, that of left valve joining anterior muscle impression at its lower posterior angle.

"Distinguishable from *M. secta* by smaller size, less convex valves, less altitude, longer straight posterior margin, and larger, less prominent ligamental callus; from *M. inquinata* by larger, longer shell, less convex valves, less relative altitude, straight dorsal margin with truncation posteriorly, and by less central umbones; from *M. yaldiformis* by more cuneiform posterior extremity, long, straight, posterior dorsal margin, and by having beaks anterior to center rather than posterior; from *M. indentata* by beaks being more anterior, being broader, and by lacking the prominent folds, indentation of ventral margin, and prominent projection of posterior extremity; from *M. kelseyi*, which closely resembles it, by broader shell and by more oblique truncation of posterior extremity. . . ."

Dimensions: Length, 30 mm.; alt., 22 mm.

Living: Alaska to San Diego; Kamtschatka (Cooper).

Pleistocene: Santa Barbara to San Diego (Cooper); San Pedro; San Diego; Ventura (Arnold); Lummi; Blaine.

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8. Loc. cit., p. 163.

Pliocene: Eagle Prairie and Danger creek, Humboldt county, California; Santa Rosa; San Fernando (Cooper); San Diego (Arnold).

Miocene: Sunol, Alameda county; Foxin's, Santa Barbara county, California (Cooper).

Macoma indentata (CARPENTER) (?). Figure 11.

Arnold's description (in part).[9] Shell rather narrow, suboval, compressed, thin; umbones slightly posterior to center; anterior end long and evenly rounded; posterior dorsal line straight; posterior extremity much projected and sharply rounded; fold prominent.

Dimensions: Length, 14 mm.; alt., 10.5 mm.; umbo to posterior extremity, 8.5 mm.; to anterior extremity, 10 mm.

This shell is like *M. indentata* described by Arnold, except it is much smaller.

Macoma inquinata (DESHAYES). Figure 12.

The only specimen obtained is the broken left valve represented in the figure.

Shell convex, thin; umbones subcentral; anterior end dilated; posterior end evenly arcuate from umbo and acutely rounded at posterior end.

Dimensions: Length, 11.5 mm.; alt., 8 mm.; umbo to anterior extremity, 7 mm.; to posterior extremity, 7 mm.

This shell is also much smaller than *M. inquinata* described by Arnold.[10]

Macoma concentrica (BURG.) Figure 13.

Though much broken, this shell was easily identified by comparing it with specimens in the university museum at Seattle. It resembles *M. nasuta* very much, except that its umbones are slightly posterior and the fold on right valve is less prominent.

Dimensions: Length, 33 mm.; alt., 22 mm.; thickness of right valve, 2.5 mm.; umbones to anterior extremity, 18 mm.; to posterior extremity, 15 mm.

Living: In Florida.

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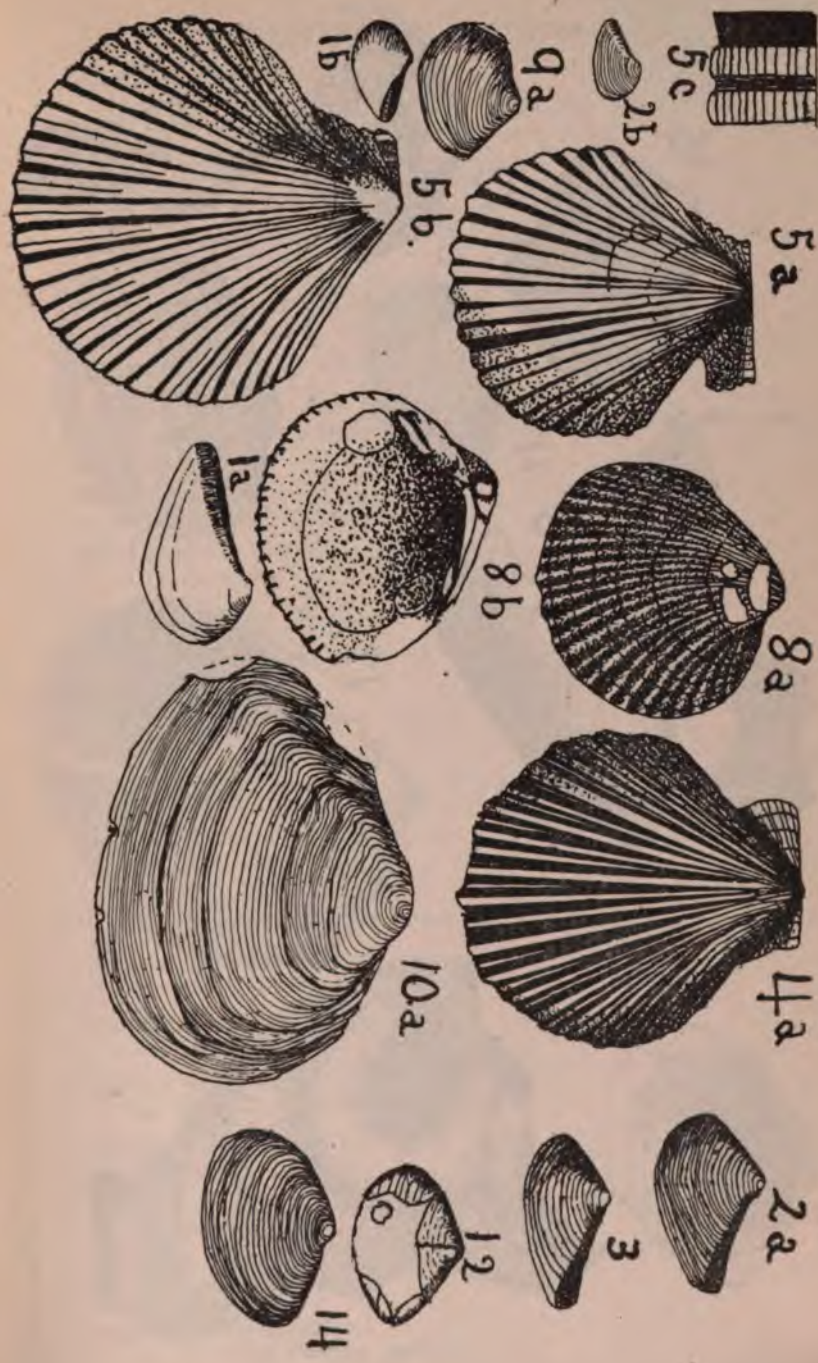
9. Loc. cit., p. 161.

10. Loc. cit., p. 162.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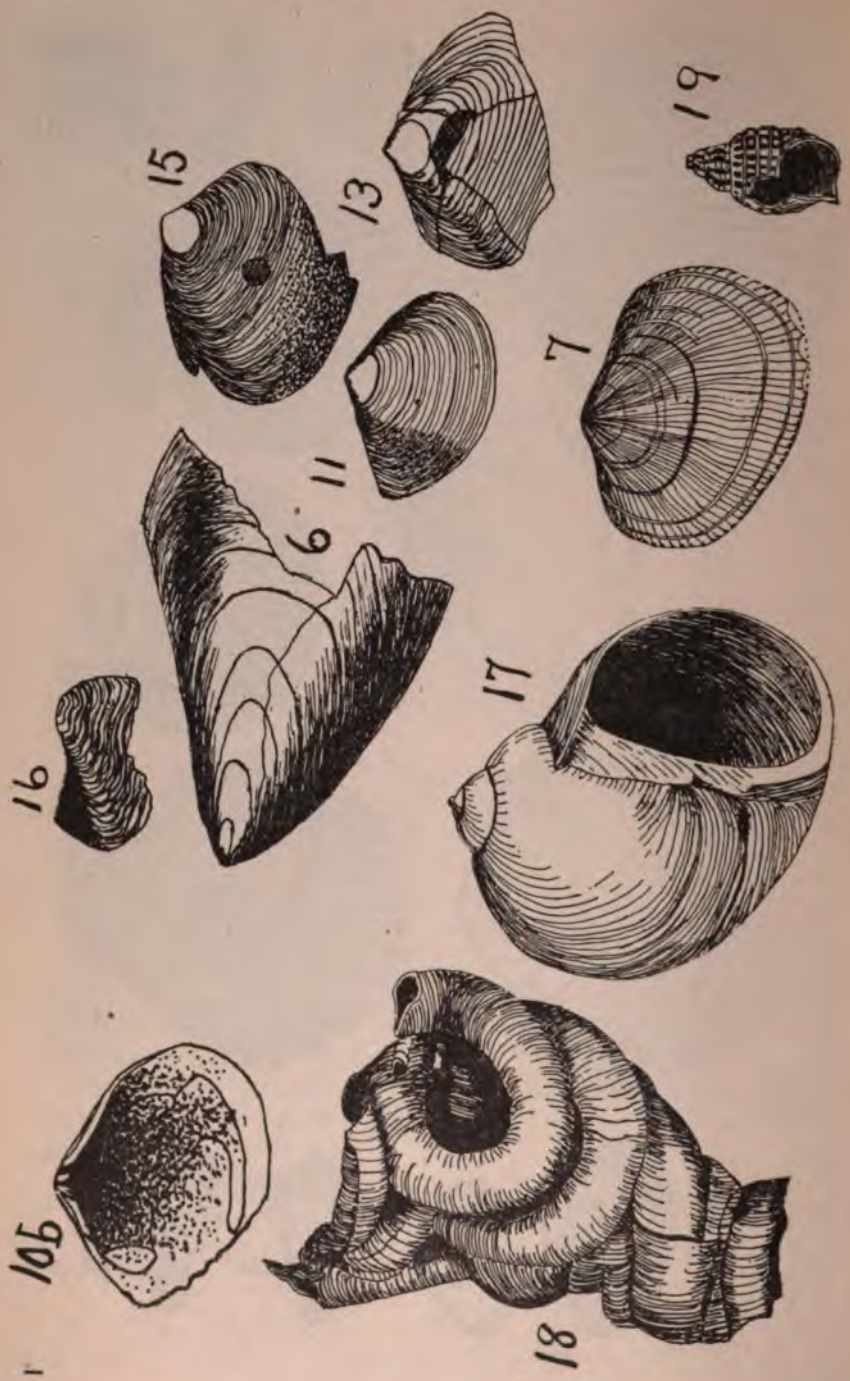
15
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10b
18

EXPLANATION OF PLATES.

Leda fossa (Baird).
1*a*. Right valve, 1-1.
1*b*. Left valve, 1-2.

Leda hamata (Carpenter).
2*a*. Left valve, 1-1.
2*b*. Right valve, 1-2.

Leda tenuisulcata (Stimp.)
3. Left valve, 1-1.

Pecten (Chlamys) jordani (Arnold).
4*a*. Left valve, 1-2.

Pecten rubidos (Hds.) (?).
5*a*. Left valve, 1-2.
5*b*. Right valve of old specimen, 1-2.
5*c*. An enlarged double rib of 5*b*, showing lines of growth, magnified.

Septifer bifercatus (?).
6. Part of left valve, 1-1.

Tapes staminea (Conrad).
7. Left valve, 1-1.

Cardium nuttallii (Mart.)
8*a*. Right valve, 1-2.
8*b*. Inside of right valve, 1-2.

(?) Abra (?).
9*a*. Left valve, 1-1.

Macoma nasuta (Conrad).
10*a*. Right valve, 1-1.
10*b*. Inside of left valve, 1-2.

Macoma indentata (Carpenter) (?).
11. Right valve, 1-1.

Macoma inquinata (Deshayes).
12. A much broken left valve, 1-1.

Macoma concentrica (Burg.)
13. Broken right valve, 1-2.

Macoma tampaensis (Conrad) (?).
14. Left valve, 1-1.

Macoma yaldiformis (?).
15. Broken left valve, 1-1.

Saxicava rugosa (Linn.)
16. Right valve, 1-1.

Natica (Cryptonatica) clausa (Broderip and Sowerby).
17. Drawing showing aperture, 1-1.

Vermetes species.
18. Drawing, 1-1.

Ocinebra interfossa (Cpr.)
19. Drawing showing aperture, 1-1.

Macoma tampaensis (CONRAD) (?). Figure 14.

Shell ovate, rather inflated, thin; umbones subcentral to slightly posterior to center; anterior end slightly rounder than posterior; no fold shown; ligamental area short, scooped out.

Dimensisions: Length, 13 mm.; diameter, 8 mm.; umbones to anterior extremity, 7.5 mm.; to posterior extremity, 6.5 mm.

Living: Gordon's Pass, Fla.

Macoma yaldiformis (?). Figure 15.

Shell ovate to elongate ovate, compressed, thin; anterior end dilated; posterior end slightly cuneiform, extremity somewhat truncated; posterior dorsal margin short, straight; fold carinated on right valve; umbones posterior; two (?) cardinal teeth in right valve (left valve not seen); ligament external, short, straight; pallial sinus large, wavy, expanding inside.

Dimensions: Length, 18 mm.; diam., 12 mm.; umbones to posterior end, 8 mm.; to anterior end, 11.5 mm.

Saxicava rugosa (LINN.) Figure 16.

Shell very variable in outline, generally angular oblong-ovate, convex, thick; surface ornamented with conspicuous concentric lines which give the surface a rugose appearance, these being more prominent along the angles of the shell; hinge area prominent; one prominent, well-forward tooth in the right valve (left valve not seen).

Dimensions: Length, 11 mm.; alt., 6 mm.; umbones to anterior extremity, 9 mm.; to posterior extremity, 3.5 mm.

Living: Port Orchard, Wash. (Kincaid).

Natica (Cryptonatica) clausa (BRODERIP AND SOWERBY). Figure 17.

Arnold's description:[11] "Shell of medium size, ovate-globular; spire only slightly elevated; whorls four, evenly convex, though sometimes slightly shouldered; surface smooth, except for fine incremental lines; suture impressed, distinct; aperture semilunar; outer lip sharp; inner lip callous and reflected completely over the umbilicus.

Living: Arctic ocean; Alaska; north Atlantic (Cooper).

Pleistocene: Santa Barbara to San Diego (Cooper); San Pedro; Santa Barbara (Arnold).

Pliocene: San Pedro, Santa Barbara (Arnold).

Dimensions: Alt., 27 mm.; lat., 26.5 mm.; aperture, 19.5x12 mm.

11. Loc. cit., p. 313.

Ocinebra interfossa (CPR.) Figure 19.

Shell fusiform; spire elevated; whorls five in number, each ornamented by five (and a trace of the sixth) rough, subangular, spiral lines which are very prominent on the anterior-posterior portion of the shell; also by cross-lines in the posterior portion and by incremental lines near suture; suture deeply appressed, distinct; aperture subelliptical; outer lip thickened; canal shallow, produced by an angulation of the lip.

Dimensions: Alt., 10 mm.; lat., 6 mm.; aperture, 5.5x4.5 mm.

Vermetes species. Figure 18.

Specimens of this species are abundant in this clay. They usually crumble, however, on exposure to the air.

ENGLACIAL AND SUBGLACIAL TILL.—This till covers practically the whole area, even the estuary regions, it being worked over wholly or in part in these regions by sea action. Its composition is principally sands and gravels to which a great number of boulders are added in the morainic regions. The formations of this till, the most conspicuous of which are marked on the map, are lateral moraines, dump-terminal moraines, push-medial moraines, kames, and kettle-holes, drumlins, ridge-eskers, overwash-marine delta deposits, etc.

LATERAL MORAINES.—A ridge apparently of this type was observed southeast of the northeast diagonal road leading into Bellingham. It was not examined, but its position would seem to indicate that it was such a moraine.

DUMP-TERMINAL MORAINES.—A moraine of this type extended from Blaine south along Georgian Bay to the portage, the Lummi peninsula being the southern end of this moraine. Here boulders do not appear in great numbers on the surface, for reasons which will appear later; but at all places where the sea is making inroads into the land along the bay, the beach is strewn with granite and other plutonic "niggerheads." The foot of the glacier was sometimes further out to sea than the present morainic line; at other times further in on the estuary side. The different dumping-places left sink-holes between them, which are now kettles or lakes; Lake Terrel is an example.

PUSH-MEDIAL MORAINES.—A morainic strip of this type, as we have seen, extends from near Sumas City and Abbott's Ford, in Canada West, to Boundary bay and Point Roberts. It was the middle ground between the two glaciers just before their final retreat. It

is quite wide in places and constitutes the highest glacial deposits in the region. One hundred feet from the surface it was found to contain a large number of boulders and cobblestones, the remainder of its make-up being mostly gravel. Judging from the deposits, the glacier seems to have moved back and forth across this area several times, and near the close of the epoch it seems to have covered it entirely. At this time it seems to have formed a trough area between the two glaciers, and was consequently the dumping-ground. In it, both in the United States and Canada, esker rivers flowed to the sea; the largest south of the international boundary-line entered the bay at Blaine.

RIDGE-ESKERS.—Several ridges, most all of the serpentine type, are to be found in the region about Blaine and Custer and in the region just north of Bellingham. The long broken ridge in Canada seems to be an esker, but the country is too wooded to make a sufficient investigation to determine that it is. At all places where it was examined it was found to be composed of sand and gravel at its summit. An esker several miles long, standing up above the surrounding country like a railroad grade, has its sand plain in the suburbs of Blaine. Where it ends abruptly at the edge of the old Nooksack estuary it is forty-five feet higher than the land on which it is situated. Its course is serpentine, in a western direction. At a place or two it gives off ridges; at others ridges join it. It is composed mostly of gravel at its eastern terminus; but, as Blaine is neared, partly stratified sand becomes the predominant material. It was evidently deposited in a large superglacial stream—a stream that followed the normal course of the Nooksack river and reached the sea by the shortest route. Ridges of esker type cross the Parallel road several places between Bellingham and Lynden. Similar ridges were also seen at Custer and Mountain View.

KAMES AND KETTLE-HOLES.—In the push-medial morainic area east of Blaine in the inter-esker spaces the country is very knolly and contains many kettles. Most of the hills (marked drumlins on the map) seem to have been formed by the unequal melting of the ice at the glacial margin at the final retreat of the ice-sheet, the superimposed boulders and larger masses of till partially protecting the ice beneath them from melting. The unprotected portions of the ice would melt soonest, forming depressions. Into these the superimposed till on the protected areas would finally be dumped by lateral sliding; and, when the ice finally disappeared, would remain as kames (called drumlins by some writers). The portions of the ice that melted slowest would now represent kettle-

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holes. These kame-hills and kettles also seem to be intimately connected in origin with the ice edge and to be due to marginal conditions, such as the incorporation of ice fragments in the till, the grounding of blocks of ice, the movement of the ice edge, and the development of underground ice-sheets. Similar kames and kettles were also found in other parts of the glaciated region. Several kettles were noticed at Mountain View.

DRUMLINS.—There are several boat-shaped knolls and ridges east and north of Bellingham in the lee of the now existing Eocene-capped hills, or of some projecting hard substance now beneath the surface which resisted the wear and erosion of the ice. These hills seem to have collected in a way similar to the way snow drifts behind a wind obstruction, except that they were closed in at the top and on the sides by ice.

SAND-PLAINS.—There are several sand-plains in the region, but the only one specially noticed is that at Blaine, previously mentioned.

OVERWASH AND GLACIAL MARINE DELTA DEPOSITS.—These are given together here because the first merges into the second. The whole area south of Blaine, except the estuary part, is covered with overwash material which was deposited at or just below sea-level, as is attested by the marine fossils. It is composed mostly of sand, and ranges from a few inches to several feet in thickness. On the Lummi peninsula, south of Fish Point, it was found to have been dumped into the sea beyond the terminal moraine. There it accumulated to a great thickness.

RECENT DEPOSITS.—These are: Tide-water, semitide-water, beach, delta, estuary, lake and swamp deposits.

TIDE-WATER DEPOSITS.—These cover the area between high and low tide-water marks both at the heads of Bellingham and Lummi bays. They are composed mostly of sand. They are valued principally for the setting of salmon nets and fish-traps, and for their clam-beds.

SEMITIDE-WATER LANDS.—These lands are situated at the mouth of the Lummi river, and in the vicinity and to the northwest of Marietta. They are flats over which high tides sometimes flood. They are composed of marine sand and silt. They are seepy, sour areas, which are mostly worthless.

BEACH DEPOSITS.—These form the spits of the region, also the narrow neck of land at the portage, and a narrow strip along the coast in the vicinity of the government day-school building.

They are composed mostly of gravel and cobblestones. The spit at Blaine is used as a site for fish canneries. The other spits are used as camping-places in the fishing season.

DELTA DEPOSITS.—These cover large areas both at the mouth of the Fraser and the Nooksack-Lummi rivers. The Nooksack delta is quite thick. Logs in it have been found thirty feet beneath the surface. This delta, where it is not swampy, contains some of the best farms of the region. There are also some fine farming sections in the Fraser delta.

ESTUARY DEPOSITS.—These are found in the valleys of the Fraser and Nooksack rivers, above the respective deltas. As has been stated, these regions were at or below sea-level at the close of glacial times. While thus depressed a coarse, ash-gray sand was spread over the Nooksack estuary from a few inches to many feet in thickness. The thickest deposit of this sand is on the west or slack-water shore of the estuary (the glacial sands are finer and are all brown to light yellow in color). While this sand was being deposited in the slack-water region away from the mouth of the Nooksack river, that river was depositing gravel on the current side. Besides that the waves of the estuary were forming beach gravel by their pounding against the walls of the Sumas mountains on the east and by their tearing down and leaching out the finer material of the glacial deposits of the push-medial moraine to the northwest, the coarser material being left behind as gravel and cobblestones. That these deposits were laid down in sea-water is attested by the fact that they all contain marine shells. Sea-shells were found in them seventy feet above present sea-level. The sites of these estuaries are now occupied, in part, by low prairies; the Bertrand prairie is situated in the Nooksack estuary, the Langly prairie in the Fraser.

LAKE DEPOSITS.—Deposits of this type are often very thick. They are composed mostly of sand, silt, and peat.

SWAMP DEPOSITS: These cover a great part of the delta and estuary areas and are also found bordering the glacial lakes. The swamps of to-day, however, cover a much less area. The deposits are composed mostly of black muck and peat. When tiled the swamp regions make fine farming lands.

LAKES.

The lakes, besides Lake Whatcom (of which no examination was made), are Wiser, Gamble, Terrell, Judson, and Sumas.

Wiser lake is the lower end of a low area which seems to be an abandoned channel of the Nooksack river; its upper end is now a swamp. The whole area empties its surplus water into the Nooksack through a small stream which connects with the lake. The lake is from thirty to fifty feet deep. It was once much larger than at present. It is now surrounded by a marsh. In this the peat deposit is very thick; at places it is over twenty feet. The peat west of the lake covers over 400 acres. This is being ditched and will soon be farmed.

Gamble lake seems to be a closed slough of the Nooksack—an abandoned channel from which a small stream flows to the river.

Lake Terrrell was caused by the terminal moraine making a second halt in its retreat here; the space between the two dumping-grounds is now occupied by the lake. This lake, which is now very shallow, has had about three times its present dimensions. The prevailing wind which has blown over it has been from the northeast; this has caused the waves to etch away the bluffs on its west and southwest sides. This chopping process finally cut an outlet. In the etching-out process the finer material was carried back into the lake and has been no small factor in filling it up. The coarser sand and boulders were left behind on the lake front as a characteristic lake deposit. On account of the filling up of the lake and the lowering of its level by its having cut an outlet, much of the area mapped is a swamp. In this, peat has deposited to a depth of three feet. This swamp region is now being reclaimed by ditching and tiling.

Some years ago a man attempted to drain this lake in order to take its site as a homestead. He was promptly stopped, however.

Judson lake, situated in the Nooksack valley, was caused by a beach bench of the Nooksack estuary damming its natural outlet. Its surplus water now flows north by way of Abbott's Ford to the Fraser.

Sumas lake is the remains of the Nooksack-Fraser estuary (or sound). It is now the back-water region of the latter stream; its area varies with the rise and fall of that river. It often extends as far south as Sumas City. It is very shallow except in its central part. At the time visited a company was being formed to dike it at the south. This, it was claimed, would reclaim 100,000 acres, all of which would evidently make good farm land, as its surface is composed of a stratum of peat from six inches to a foot in thickness.

STREAMS.

The principal streams of the region are the Fraser and Nooksack rivers, and the Dakota, California and Terrell creeks, and their tributaries.

The California and Dakota creeks are both flat-bottomed, wide-mouthed, mud-flat streams that are practically dry when the tide is out. They both have their source on the low divide between the Bay of Georgia and the Nooksack valley at this point. In fact, they have cut their channels back till they rise in the Nooksack valley. At one time they seem to have been channels leading out from the Nooksack estuary. They both pour their muddy waters into Semiahmoo bay.

The creek that drains Lake Judson flows out of the Nooksack valley proper, through a gorge in the glacial deposits, to the Fraser, at Mission.

The Fraser river descends from the mountains and crosses the Sumas valley and then passes through granite walls to the flats beyond, through which it flows to Georgian Bay. It is a large river, of rapid current, and is navigable to the foot-hills.

The Nooksack, a much smaller stream than the Fraser, flows from the foot-hills in a northwest direction to Lynden. At this point it turns abruptly southwestward, which direction it keeps till it reaches the point where it forms its delta. Here it divides and subdivides. The main branch empties into Bellingham bay; the minor branch into the Bay of Lummi, on the opposite side of the Lummi peninsula. On leaving the mountains it has a very rapid current, but below Lynden the stream is so near base-level that its rate of flow is much reduced. In its lower course its channels are very changeable. A change in the main channel in the '80's washed away most of the Indian village of Lummi and compelled the government to move its school buildings to save them; the site of the schoolhouse then is now in the center of the main channel of the river. A jam in the river some years ago flooded the whole country and did great damage to property. Had it not been removed by the government it would have ruined all the delta farm lands and in the end would have changed the main channel of the river to the Lummi bay side of the peninsula. This would have ruined the fishing industry of the Indians and of the white people at Marietta. The river is navigable for small boats to Lynden.

DID THE FRASER RIVER EVER FLOW THROUGH THE NOOKSACK VALLEY?

As has been previously stated, a large estuary or sound once extended up the Nooksack valley from Bellingham bay to the Sumas mountains. An arm of this sound was found to have extended north through the Sumas valley to the Fraser river, both streams then emptying into the same arm of Georgian Bay. The Fraser estuary or sound also then existed; the gap in granite barrier to the Fraser's western outlet was then probably partly cut. Probably this estuary and the Nooksack sound were one continuous sheet of water; the land west of it islands. As the country was gradually elevated above the sea the continuous sound became a swamp area and then dry land. At first the Frazer sent at least a large part of its water through the Nooksack valley to Bellingham bay; the Nooksack was then a tributary of the Fraser. The part of the Fraser, if any, flowing westward, made its way over a fall where it crosses the granite ledge that closes in the Sumas valley. As the elevation was continued, and the barrier to the western outlet of the Fraser was more and more reduced, a greater volume of that river found its way westward. Finally, as it was the larger stream and consequently could erode faster than the Nooksack, it reduced its channel to the same level at the Sumas pass as the Nooksack was at Lynden. This caused a slackened-water, or laken, region to exist between the two streams. As the Fraser crossed the narrowest part of this lake it soon filled that part of it with sediment, only a small stream connecting the lake with it, and all of the water of river found its way westward. On the other hand, the Nooksack entered the broad, shallow end of the lake, or sound, if it still continued to be a part of the ocean, on leaving the foot-hills, and there deposited its sediment in the form of a semicircular ring ten to twelve feet in height completely through the lake. The tide, coming up the outlet of the lake, or up the sound, if the Nooksack valley still remained a sound, probably aided in forming this ridge. The lowering of the stream below the lake lowered the surface of the lake, and left the ridge dry land, with the Nooksack to the south of it. This ridge is to-day the watershed between the two streams. The facts that lead up to this conclusion are these: (*a*) Throughout the level area from Lynden to Sumas lake all the wells are drive-wells, ranging from fifteen to forty feet in depth. The strata through which they are driven are sand and gravel of the river type, the depth of which is unknown. (*b*) The Sumas river, which flows almost parallel with the Nooksack river for several miles, is at the

same level as that river, and is separated from it in many places only by the low ridge previously mentioned. At Everson the Nooksack runs on one side of the depot, and the drainage of the other side is through the Sumas to the Fraser. In fact, it would not take 100 men one day with team and scraper to so change the channel of the Nooksack, at any one of several places, during high-water times, that a great part of its water would ultimately reach Georgian Bay through the Fraser. And the same is true of the latter stream during flood periods. It would back its water up through the Sumas into the Nooksack. In 1894 it flooded the Sumas prairie so that boatmen rowed to the suburbs of Sumas City in the slack water. When visited in June last it was backing water over the prairie within two miles of that city, and the Sumas river was at a stand-still at Everson There seems to be every reason to believe that should these two streams—Nooksack and Fraser—get on a "rampage" at the same time they would flood the entire flat country between them.

DID THE NOOKSACK RIVER EVER FLOW THROUGH THE SUMAS VALLEY TO THE FRASER?

To this question a negative answer can assuredly be given. Had it ever flowed there it would still do so, because, with the low divide removed, as it would then have been, the fall is decidedly northward.

POSSIBLE CAPTURE OF THE NOOKSACK RIVER BY THE FRASER.

The Fraser, on account of its volume and fall in its upper part, is eroding its channel faster than the Nooksack, and has already captured several streams in the valley of the latter. As we have seen, Lake Judson, just north of the low dividing ridge, drains into it, as does also the Sumas river, a river which rises in the very gorge through which the Nooksack descends from the mountains, and which flows almost parallel with it and at about the same level for miles. Furthermore, a very high flood, now that the timber is mostly removed, may at any time cause the Nooksack river to cut through the low divide and turn the greater part of its water into the Fraser through the Sumas river and lake. Such a catastrophe is expected by the settlers at every flood period.[12]

12. The removal of a few feet of the divide west of Lynden would turn a portion of the Nooksack river into Semiahmoo bay through the Dakota creek.

CANALS.

If the people of this region were a water-going people, like the Hollanders, they would have canals running over the country in every direction. A canal connecting the Nooksack and Fraser rivers through the Sumas river and lake route could be easily constructed, large enough to accommodate large gasoline boats; and by the use of locks still larger vessels could be used. Another canal could be almost as easily cut from the bend in the Nooksack river west of Lynden to Blaine through the Dakota creek.

WATER POWER.

No attempt was made at an investigation of this subject. It is very evident, however, that both the Nooksack river and the stream that drains Lake Whatcom—a stream about forty feet wide and having a fall of 318 feet in about three miles, would furnish a great amount of water power. The writer was told that the Bellingham Bay & Eastern railway has a power plant of 10,000 horse-power near Nooksack falls, about fifty-two miles by rail from the city of Bellingham; also that mills were operating on Whatcom creek, in the suburbs of Bellingham. For a complete discussion of this subject, see Professor Landes's report.[13]

WATER.

The water of the Nooksack river and of Lake Whatcom is good drinking water, and also good water for use in boilers. The water in the swampy regions is dark, similar to the color that water has in a barn-yard drain. It is very unwholesome. The water in all the wells near the seashore or in low areas, except in the Nooksack-Sumas prairie region, is brackish, and unfit for use. All the wells in the Sumas valley that have their source in the underlying quicksand and gravel are soft and potable, and most always good water for use in boilers. The water at several places in the Bertrand prairie was found to contain considerable iron and was "hard on boilers," to use the common phrase. All the spring-water examined was pleasant to the taste.

SPRINGS.

The springs are found along the foot-hills and at the heads of the streams having their sources in this region; also in the Mountain View country and in and at the edge of the highland east of Blaine. All the springs are small and none possess medicinal properties.

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13. Loc. cit., part V, pp. 32, 33.

WELLS.

The drinking water of all the region back from the main streams is furnished by comparatively shallow wells. The wells in the Sumas valley and in the vicinity of Lynden and Everson are drive-wells, as previously stated, the water being found in gravel and sand. The wells in the vicinity of Mountain View are dug in subglacial till that is so hard that it has to be blasted. This clay is non-porous and the wells dug in it are mere cisterns, the eaves of the houses or barns usually furnishing the water.

MINERALS.

SAND.—Glacial sand covers all the highlands from Blaine to the portage. It is a light brown, usually very fine sand. Some of it is good for plastering purposes, but most of it is too fine. A great deal of it would make good molding sand, and would also be good in city paving and in macadamizing roads. The soil of the region over which this sand is spread is very poor.

The ash-gray sand of the delta formation is coarse, and is, consequently, good plastering sand. Large areas of it are found between Custer and Ferndale. It is of great depth in these localities, and, as the railway crosses them, it could be easily shipped.

GRAVEL.—Extensive gravel areas occur at several places, the locations and approximate areas of which are marked on the map, but not their outline in detail. Some of the gravel deposits are glacial in origin; others, estuary and beach deposits; and those west, and in the vicinity of Lake Judson, worked over or repiled glacial material. A great part of the gravel was found in low sections; but the gravel in Canada and that just east of Blaine is on high land. On the whole the gravel is a coarse variety in which are embedded many cobbles and boulders. It is now being used extensively for macadamizing roads; and, as the supply is inexhaustible, there is no reason why this region should not have first-class roads in a few years.

GARNETS.—Garnets are found on both beaches of the Lummi peninsula. They are obtained from the schists, principally from the mica schists. These schists on weathering and crumbling to dust on the highlands leave the harder garnets to be carried to the shore line by the streams. Here they are found in the beach sand. Garnets are also found at several places in the glacial deposits.

GOLD.—The black sand of the Lummi Bay beach carries gold; but there is so much verdigris in the water and sand that it is diffi-

cult to wash it out. So far there has not been enough found to make it pay.

COAL.—The coal seams examined in British Columbia were all coal of the lignitic type. At one place several tunnels had been made and coal had been mined at several different times, but had each been abandoned; the seams were too thin and the coal contained too much dirt. Probably by sinking shafts, thicker veins and a better quality of coal could be obtained.

The Eocene formation in the vicinity of Bellingham contains several coal-seams of workable coal; but a study of them and of the mines of the region was not made by the writer. A description of them, however, may be found in Professor Landes's report.[13]

SOIL.

The soil is very variable. In the glacial overwash regions it may vary from a few inches of loam to sand, gravel and clay all in the same dooryard. On the highlands east of Blaine, except in the sand and gravel districts, it is usually good. In the Sumas valley about Sumas City it is so light that it is blown from stumps, leaving the roots bare. In the immediate vicinity of Sumas City and lake it is deep, and ranges from a dark black muck to peat, from six inches to three feet in thickness. In all the swamp areas it is decayed peat.

The region is fast becoming a farming section.

Loc. cit., part I, p. 47.

SOME ANIMALS DISCOVERED IN THE FOSSIL BEDS OF KANSAS.

By Charles H. Sternberg, Lawrence, Kan.

FOR many years past the writer of this paper has given his entire time to the collection and preparation for exhibit of fossils from several Western states, giving much time to the rich fields of western Kansas, so prolific in fine examples of ancient vertebrate life. Some mention of some of the best finds made within the last few years and where these have gone, many being lost forever for any Kansas museum, is worthy of record.

A complete skeleton of a new plesiosaur was found by the writer's son on the Hathaway ranch, on Beaver creek, Logan county, and which is now in the museum of the University of Kansas, having been mounted by the very competent preparator, Mr. H. T. Martin.

A nearly complete skeleton of *Portheus colossus*, of Cope, collected on Robinson's cattle ranch, in Logan county, within a stone's throw of the stable, is now mounted in the American Museum, at New York, and is said to be the best example of a fossil fish in any museum in the world.

There have also been sent to this museum from the Kansas fields eight other splendid specimens, including a very fine skull of the great ram-nosed *Tylosaurus* and the skeleton of a smaller form of *Portheus*. This has enabled that museum to restore and mount a nearly complete skeleton procured some years ago from Mr. W. O. Bourne, of Scott City, Kan., in which the head was distorted. This fine skull was found on Butte creek, 100 feet above where the writer had previously, in 1881, found as good a one, which is now in the Museum of Comparative Zoology, at Cambridge, Mass.

To Vassar College was sent a fine skeleton of *Clidastes* and also one of *Platecarpus*, both from Logan county.

To the Carnegie Museum, at Pittsburg, Pa., much material has been sent, including the most complete skeleton of *Protostega* ever found in the Kansas chalk-beds. This great turtle measured ten feet between the front paddles. There was also sent this museum a fine skeleton of the great predaceous fish, *Portheus colossus*.

To the British Museum has gone quite a collection, including a nearly complete skeleton of the great broad-handed lizard, *Platecarpus oxyphaeus*, a nearly complete skeleton of a *Pteranodon*, with the best skull that the writer has ever collected. There was also

included a fine pair of fins with pectoral arches connecting them of the well-armed snout-fish, *Protosphyræna.* Each fin, enameled and sharp as a knife, with forty teeth, is three feet in length. What must have been a strong and effective weapon of offense or defense is shown in a skull of this same fish, with its long, bony rostrum, oval in section and terminating in a sharp point. In addition to this dagger, fixed at the end of the head, the snout-fish possessed eight sharp, lancet-shaped teeth that projected forward. When the sharp point of the rostrum was driven into the victim's side these lancets widened the rent, till the animal's head could be forced into the breach up to its eye-rims, while their forward slant enabled the head to be quickly withdrawn for a fresh attack. Even the Kansas mosasaurs, who were no mean fighters themselves, must have avoided this great fighter among fishes.

A nearly complete skeleton of this same lizard is displayed in the museum of the University of Iowa. This was a large specimen, twenty-five feet in length, with the bones well bedded in the natural chalk.

The finest saurian ever found on any of the writer's expeditions came from the Mendenhall pasture, on Hackberry creek, in Gove county. The specimen was complete, except for the upper portion of the head. The massive jaws are present, and the bones generally are beautifully preserved, and so little distorted by pressure that the specimen can be given an open mount. Even the breast-bone and the cartilaginous ribs are present, this being the first time that these bones have been found in the remains of this animal. This fine specimen of *Platecarpus coryphæus* was sent to the Roemer Museum, at Hildersheim, near Hanover, Germany.

The first restoration of a *Platecarpus* skeleton ever attempted in the United States, the material being from Kansas beds, was sent to Doctor Krantz, a dealer of Bonn, Germany. With this went the material for an open mount of the Kansas rhinoceros, *Teleoceras fossiger*, from the Sternberg quarry, near Long Island, Kan.

There has been sent to the Munich Museum a complete set of lower jaws and also a number of inferior tusks of *Mastodon productus* (Cope).

The same museum possesses an unusual specimen of an ancient shark, *Oxyrhina mantelli*, found on Hackberry creek, Gove county, Kansas, in 1890. The remarkable thing about this specimen is that the vertebral column, though of cartilaginous material, was almost complete, and that the large number of 250 teeth were in position. When Chas. R. Eastman, of Harvard, described this

specimen, it proved so complete as to destroy nearly thirty synonyms used to name the animal, and derived from many teeth found at various former times. In addition to the above-mentioned vertebrate fossils, the writer has gathered many of lesser perfection or importance, as well as everything that came in his way illustrative of the life of former geologic times. The beds of Kansas have proved to be rich territory and to possess material of very great scientific interest, as is evidenced by the desire of the various museums mentioned above to secure fine illustrative examples of this ancient Kansas fauna.

The discovery and collection of these has been a constant source of joy and pleasure, entirely aside from any financial value they hold. On the other hand, it has been a very great disappointment that these things, of such great scientific interest, had to leave the state. Instead of finding a natural home at the University, the museums of the capital, or with the educational institutions of the state, they are scattered in other states, or even across the sea. Moreover, the finding of each new and valuable specimen reduces the probability of finding more in the years to come. The writer has tried to bring to a successful issue several movements through which the results of his collecting expeditions in Kansas would remain within the boundaries of the state—within the district where the huge and strange forms lived their lives. To his regret he has so far failed.

IV.

BIOLOGICAL PAPERS.

"LIST OF SPECIES OF HYMENOPTERA COLLECTED BY THE UNIVERSITY OF KANSAS ENTOMOLOGICAL EXPEDITIONS OF 1902, 1903, 1904, 1905, AND 1906."
By F. H. SNOW, University of Kansas, Lawrence.

"RESULTS OF THE ENTOMOLOGICAL COLLECTING EXPEDITION OF THE UNIVERSITY OF KANSAS TO PIMA COUNTY, ARIZONA, IN JUNE AND JULY, 1906."
By F. H. SNOW, University of Kansas, Lawrence.

"LIST OF SPECIES OF COLEOPTERA COLLECTED IN NEW MEXICO BY THE ENTOMOLOGICAL EXPEDITIONS OF THE UNIVERSITY OF KANSAS."
By F. H. SNOW, University of Kansas, Lawrence.

"CONTRIBUTIONS TOWARDS A CATALOGUE OF INSECTS OF KANSAS, RESULTING FROM PERSONAL COLLECTING."
By ELBERT S. TUCKER, University of Kansas, Lawrence.

"NOTICE OF SOME NEW ELEMENTS IN UINTACRINUS."
By H. T. MARTIN, University of Kansas, Lawrence.

"ADDITIONS TO THE LIST OF KANSAS BIRDS."
By F. H. SNOW, University of Kansas, Lawrence.

"SOILS AND BACTERIA."
By L. C. WOOSTER, State Normal School, Emporia.

"NOTES ON THE KANSAS BIRD LIST."
By D. E. LANTZ, Washington, D. C.

"ADDITIONS AND CORRECTIONS TO THE LIST OF KANSAS MAMMALS."
By D. E. LANTZ, Washington, D. C.

"IS THE GILA MONSTER A VENOMOUS REPTILE?"
By F. H. SNOW, University of Kansas, Lawrence.

"NOTES ON THE BIRDS IN THE BABOQUIVARI MOUNTAINS DURING THE MONTHS OF JUNE AND JULY."
By L. A. ADAMS, University of Kansas, Lawrence.

"FOOD HABITS OF KANSAS LIZARDS AND BATRACHIANS."
By F. A. HARTMAN, Wichita.

"CERTAIN CONDITIONS TO BE MET BY INSECT COLLECTORS."
By ELBERT S. TUCKER, University of Kansas, Lawrence.

"ADDITIONS TO THE LIST OF KANSAS COLEOPTERA FOR 1906."
By W. KNAUS, McPherson.

LIST OF SPECIES OF HYMENOPTERA

Collected in Arizona by the University of Kansas Entomological Expeditions of 1902, 1903, 1904, 1905, and 1906.

By F. H. SNOW, University of Kansas, Lawrence.

THE determinations of species not already in the collection of the University of Kansas were made by Mr. H. L. Viereck, of the Academy of Natural Sciences of Philadelphia, assisted in certain families by Profs. H. T. Fernald, A. D. MacGillivray, and T. D. A. Cockerell, and Mr. C. T. Brues, to all of whom grateful acknowledgments are hereby tendered. There are still a considerable number of species not yet reported, which will be published at a later date. The localities are given in connection with each species. Oak Creek Canyon camp was made at Thomas's ranch, twenty miles southwest of Flagstaff, in Coconino county, altitude, 6000 feet; the camp at the base of Humphrey's Peak, in Coconino county, was at an altitude of 9500 feet; Congress Junction is in Yavapai county, 125 miles south of Ash Fork, altitude, 3000 feet; the Bill Williams Fork camp, was near Tappan's ranch, on the dividing line between Mojave and Yuma counties, altitude, 1000 feet; San Bernardino ranch is in the southeast corner of Arizona, in Cochise county, our camp being located eighteen miles east of Douglas, altitude, 3750 feet. Tucson and the Baboquivari Mountain camps are in Pima county, at an altitude of 3100 feet and 3750 feet.

Family TENTHREDINIDÆ.

Atomocera ruficollis Norton. Oak creek, 1 specimen.
Hylotoma conspiculata Macgillivray, new species. Oak creek, 1 specimen.
Pristiphora siskiyouensis Marlatt. Oak creek, 1 specimen.
Pteronus coloradensis Marlatt. Oak creek, 1 specimen.
Selandria media Norton. Oak creek, 1 specimen.
Tenthredo variegatus Norton. Oak creek, 11 specimens.
xanthus Norton. Oak creek, 7 specimens.
undetermined species. Oak creek, 1 specimen.

Family SIRICIDÆ.

Cephus cinctus Norton. Oak creek, 1 specimen.
Sirex albicornis Harris, var. californicus Norton. 4 specimens.

Family EVANIIDÆ.

Gasteruption pexplexus Cresson. Oak creek, 1 specimen.

Family ICHNEUMONIDÆ.

Ichneumon allapsus Cresson. Humphrey's Peak, at base and summit, 3 specimens.
animosus Cresson, var. rubellus Cresson. 1 specimen.
arizonensis Viereck, new species. Oak creek, 1 specimen.
citrinifacialis Viereck, new species. Oak creek, 2 specimens.
hemimelanarus Viereck, new species. Oak creek, 1 specimen.
humphreyi Viereck, new species. Humphrey's Peak, at base, 1 specimen.
lætus Brulle. Oak creek, 1 specimen.
longulus Cresson. Oak creek, 1 specimen; San Bernardino ranch, 3.
maurus Cresson. Oak creek, 1 specimen.
nigrosignatus Viereck, new species. Oak creek, 1 specimen.
vittifrons Cresson. Oak creek, 1 specimen.

Hemiteles lathroscopoides Viereck, new species. Oak creek, 4 specimens.

Pezomachus homalommoides Viereck, new species. Oak creek, 1 specimen.

Cryptus albotarsis Cresson. Oak creek, 1 specimen.
consobrinus Viereck, new species. Oak creek, 1 specimen.
politicalypterus Viereck, new species. San Bernardino ranch, numerous specimens.

Theronia fulvescens mellipennis Viereck. Oak creek, 10 specimens.

Pimpla annulipes Brulle. Oak creek, 1 specimen.
pedalis Cresson. Oak creek, 1 specimen.

Ophion purgatum Say. Baboquivari, 1 specimen.

Glypta egregiafovea Viereck, new species. Oak creek, one specimen.

Nototrachys ejunoidus Say. Oak creek, 1 specimen.
reticulatus Cresson. Oak creek, numerous specimens.
texanus Cresson. Oak creek, numerous specimens.

Bassus lætatarius Fab. Oak creek, two specimens.

Thyreodon morio Fab., race transitionalis Vier., new race. Oak creek, 2 specimens.

Paniscus geminatus Say. Oak creek, Bill Williams fork, Baboquivari, 1 specimen at each place.

Amblyteles hudsonicus Cresson. Oak creek, 1 specimen.
nubivagus Cresson. Humphrey's Peak, at base, 1 specimen.

Family BRACONIDÆ.

Chelonus altitudinis Viereck, new species. San Bernardino ranch, 2 specimens.
exogyrus Viereck, new species. Bill Williams fork and San Bernardino ranch, 1 specimen at each camp.
nucleolus Viereck, new species. Oak creek, 1 specimen.
texanoides Viereck, new species. Bill Williams fork, 1 specimen.

Agathis vulgaris Cresson. San Bernardino ranch, 1 specimen.

Crassomicrodus nigricaudus Viereck, new species. San Bernardino ranch.

Iphiaulax cinnabarinus Viereck, new species. Bill Williams fork, 1 specimen.
faustus Cress. Bill Williams fork, 2 specimens.
perepicus Viereck, new species. Bill Williams fork, 2 specimens; San Bernardino ranch, 2 specimens.
propinquus Viereck, new species. Oak creek, 1 specimen.
rugator Say. Bill Williams fork, 5 specimens.

Vipio erythrus Viereck, new species. Bill Williams fork, 2 specimens.

Family ENCYRTIDÆ.

Copidosoma gelechiæ Howard. Oak creek, 1 specimen.

Family PERILAMPIDÆ.

Perilampus cyaneus Brulle. Oak creek, 2 specimens.
hyalinus Say. Oak creek, 1 specimen.
Euperilampus opacus Ashmead. Oak creek, 1 specimen.

Family CHALCIDIDÆ.

Leucospis affinis Say. Oak creek, 1 specimen; Congress Junction, 1 specimen.
bicincta Viereck, new species, 1 specimen.
sulcata Westw. Oak creek, 2 specimens.
Stomatoceras, undetermined species. Congress Junction, 1 specimen.
Spilochalcis torvina Cresson. Oak creek, 2 specimens.
Chalcis flavipes Fab. Oak creek and San Bernardino ranch, 1 specimen at each camp.
Acanthochalcis argenteomaculata Ashm. Bill Williams fork, Congress Junction, San Bernardino ranch, and Tucson, numerous specimens.

Family FIGITIDÆ.

Eucoila impatiens Say. Oak creek, 1 specimen.
Figites coloradensis Ashm. Oak creek, 1 specimen.

Family SCELIONIDÆ.

Scelio venata Brues, new species. Baboquivari, 1 specimen.

Family DIAPRIDÆ.

Family CHRYSIDIDÆ.

Ceratopria, undetermined species. Oak creek, 1 specimen.
Notozus marginatus Patton. Oak creek, one specimen.
Holopyga horus Aaron. Oak creek, 1 specimen.
Tetrachrysis cæruleus Fab. Oak creek, 1 specimen; Tucson, 16.
intricata Brulle. Congress Junction. 1 specimen.
lauta Cress. Oak creek, 6 specimens.
tripartita Aaron. Oak creek and Tucson, 1 specimen at each place.
Metapochia, undetermined species. Oak creek, 1 specimen.
Parnopes westcotti Mell. and Brues. Bill Williams fork, 1 specimen.

Family FORMICIDÆ.

Camponotus castaneus Latr., var. americanus Mayr. Oak creek, 4 specimens.
lævigatus Smith. Oak creek, 1 specimen.
maculatus Latr., var. mccooki Forel. Oak creek, 4 specimens.
Formica fusca Linn., var. subpolita Mayr. Bill Williams fork and San Bernardino ranch, several specimens each.
var. neoclara Emery. Tucson, 2 specimens.
var. argentata Wheeler. Baboquivari, 1 speceimen.

Family DORYLIDÆ.

Labidus mexicanus Smith. San Bernardino ranch, 1 specimen.

Family MYRMICIDÆ.

Pogonomyrmex barbatus Smith. Congress Junction, numerous specimens.
barbatus Smith, var. nigrescens Wheeler. Cactus Plain, 7 specimens.
californicus Buckley. Baboquivari and Bill Williams fork, 1 specimen at each place.
occidentalis Cresson. Oak creek, numerous specimens.

Family MUTILLIDÆ.

Mutilla ægina Cresson. Oak creek, 8 specimens; San Bernardino ranch, 1 specimen.
bellona Cresson. Oak creek, 3 specimens; Humphrey's Peak, 1 specimen.
californica Rad. Oak creek, 13 specimens; Baboquivari, 1 specimen.
fulvohirta Cresson. Baboquivari, 1 specimen.
gloriosa Sauss., var. Congress Junction, Bill Williams fork, San Bernardino ranch, Baboquivari, several specimens.
montivaga Cress. San Bernardino ranch, 1 specimen.
oajaca Blake. San Bernardino ranch, 12 specimens; Tucson, 4 specimens.
ochracea Blake. Congress Junction, 1 specimen.
orcus Cresson. Congress Junction, Oak creek and Bill Williams fork, 1 specimen at each camp; Baboquivari and Tucson, several specimens; San Bernardino ranch, 21 specimens.
pacifica Cress. Bill Williams fork, 1 specimen.
propinqua Cress. San Bernardino ranch, 1 specimen.
sackenii Cress. Congress Junction, 2 specimens; Bill Williams fork, 21 specimens.
snoworum Cockerell and Fox. Oak creek, 1 specimen.

Photopsis belfragei Bdv. Tucson, 2 specimens; Baboquivari, 1 specimen.

Brachycistis glabrella Cress. San Bernardino ranch, 6 specimens; Tucson, 1 specimen.

Family TIPHIIDÆ.

Tiphia tarda Say. Bill Williams fork, Oak creek, Congress Junction, and San Bernardino ranch, 2 specimens in each camp.

Paratiphia albilabris Spin. Oak creek and Bill Williams fork, 5 specimens in each camp; Tucson, many specimens.

Family SCOLIIDÆ.

undetermined species. Oak creek, 1 specimen.

Scolia fervida Burm. Congress Junction, Oak creek, Bill Williams fork, San Bernardino ranch, and Baboquivari, numerous specimens each.
new species. Bill Williams fork, 1 specimen.

Discolia hæmatodes Burm. Bill Williams fork, 1 specimen; Oak creek, 5 specimens.

Elis dives Prov. Bill Williams fork, numerous specimens; San Bernardino ranch, 1 specimen.
pilipes Sauss. Oak creek and Baboquivari, 1 specimen in each place.
pollenifera Vier., var. *a*, new species. Bill Williams fork, 2 specimens.
plumipes Drury. Bill Williams fork, numerous specimens; Baboquivari, 1 specimen.
xantiana Sauss. Bill Williams fork, 1 specimen.

Family MYZINIDÆ.

Plesia interrupta Say. Oak creek, very numerous specimens.
frontalis Cresson. Congress Junction, Bill Williams fork, and Baboquivari, numerous specimens.
hamata Say. Oak creek, numerous specimens.

Family EUMENIDÆ.

Eumenes bollii Cress. Oak creek, 5 specimens; Congress Junction, San Bernardino ranch, Tucson, and Baboquivari, 1 each.
coloradensis Cress. Oak creek, many specimens.
Odynerus annulatus Say. Congress Junction, Oak creek, and Bill Williams fork, numerous specimens; San Bernardino ranch and Baboquivari, 2 each; Flagstaff, 1; Tucson, many specimens, in some cases the males showing the female pupa of the Coleopteron, Xenos peckii Kirby, protruding from a ventral segment.
anormis Say. Oak creek, 6 specimens; Tucson, 18.
arizonensis Cam. Congress Junction, 1 specimen.
behrensii Cress. Humphrey's Peak, 3 specimens.
birenimaculatus Sauss. Humphrey's Peak, 2 specimens.
bustamenti Sauss. Oak creek, 3 specimens.
capra Sauss. Oak creek, 30 specimens.
hidalgi Sauss. Oak creek and San Bernardino ranch, 1 specimen each.
iturbidi Sauss. Oak creek, 1 specimen; Baboquivari, 3.
pratensis Sauss. Congress Junction, 4 specimens; Bill Williams fork and San Bernardino ranch, 2 each.
reflexus Cress. Oak creek, 1 specimen.
taos Cress. Congress Junction and Oak creek, 1 specimen each; Tucson, 8.
texensis Sauss. Congress Junction, 2 specimens.
tigris Sauss. Humphrey's Peak and Oak creek, several specimens from each locality.
tuberculiceps Sauss. Humphrey's Peak, 2 specimens; Oak creek, 20 specimens.
toltecus Sauss. Congress Junction and Oak creek, numerous specimens; Tucson, 8; Baboquivari, 2.
Pterochilus 5-fasciatus Say. San Bernardino ranch, 1 specimen.

Family VESPIDÆ.

Polybia flavitarsus Sauss. Oak creek and Baboquivari, many specimens each.
Polistes aurifer Sauss. Oak creek, 3 specimens; Baboquivari, several specimens.
flavus Cress. Congress Junction, Bill Williams fork, and Baboquivari, numerous specimens at each locality.
navajoe Cress. Congress Junction, 1 specimen; Oak creek and Baboquivari, many specimens each.
texanus Cress. Bill Williams fork, 50 specimens; Baboquivari, numerous specimens.
Vespa diabolica Sauss. Oak creek, 3 specimens.
occidentalis Cress. Oak creek, many specimens.

Family CEROPALIDÆ (POMPILIDÆ.)

Pepsis boguei Fox. Oak creek, 4 specimens; San Bernardino, 1 specimen; Tucson and Baboquivari, several specimens.
chrysothemis Lucas. Congress Junction, 4 specimens; San Bernardino ranch, 1 specimen; Tucson, several specimens.
cinnabarina Lucas. Oak creek, 2 specimens; San Bernardino ranch, 1 specimen; Tucson and Baboquivari, several specimens.
domingensis St. Farg. Oak creek, 2 specimens.
formosa Say. San Bernardino ranch, Bill Williams fork, and Tucson, numerous specimens.
marginata Beauv. Oak creek, one specimen; Congress Junction, San Bernardino ranch, Baboquivari, and Tucson, numerous specimens.
montezuma Smith. Oak creek, 6 specimens; San Bernardino ranch, 2 specimens.
ornata St. Farg. Congress Junction, Bill Williams fork, Tucson, and Baboquivari, numerous specimens; San Bernardino ranch, 1 specimen.
pallidolimbata Lucas. San Bernardino ranch, 1 specimen.
Ceropales fraternus Smith. Oak creek, 5 specimens.
Cryptocheilus conicus Say. Oak creek, 2 specimens.
undetermined species. Oak creek, 1 specimen.
Pedinaspis planatus Fox. Congress Junction, 1 specimen.
Anoplius algidus Sm. Oak creek, 3 specimens.
apiculatus Sm. Bill Williams fork, 2 specimens; Tucson, 1 specimen.
ferrugineus Say. Bill Williams fork, 1 specimen; Oak creek, 7; Tucson, 1; Baboquivari, 1.
fulgidus Cresson. Bill Williams fork, 1 specimen.
ingenuus Cress. San Bernardino ranch, 1 specimen.
interruptus Say. San Bernardino ranch, 4 specimens.
marginatus Say. Oak creek, 1 specimen.
philadelphicus St. Farg. San Bernardino ranch, 4 specimens.
relativus Fox. San Bernardino ranch, 1 specimen.
scelestus Cress. San Bernardino ranch, 1 specimen; Tucson, 2.
subviolaceus Cress. Bill Williams fork, 1 specimen.
tenebrosus Cress. Tucson, 1 specimen.
new species. Bill Williams fork, 1 specimen; Tucson, 1.
new species. Congress Junction, 1 specimen.
Aporus fasciatus Sm. Tucson, 1 specimen.
Priocnemis flammipennis Sm. Oak creek, 1 specimen; San Bernardino ranch, 6; Tucson, several specimens.
heiligbrodtii Cress. Humphrey's Peak and Oak creek, numerous specimens each.
terminatus Say. Congress Junction, Oak creek, and San Bernardino ranch, 1 specimen at each camp; Tucson, several specimens.
Agenia acceptus Cress. Tucson, 1 specimen.
Melanaporus dubius Fox. Oak creek, 2 specimens.
Mygnimia mexicana Cress. Congress Junction, 1 specimen; Oak creek, 1; San Bernardino ranch, 6; Humphrey's Peak, numerous specimens.

Family SPHECIDÆ.

Ammophila aberti Hald. Congress Junction, 3 specimens; Bill Williams fork, 4; Tucson, 1.
argentifrons Cress. Oak creek, 5 specimens; Tucson, 1.
communis Cress. Oak creek, numerous specimens.
gryphus Smith. Oak creek, numerous specimens.
luctuosa Smith. Oak creek, 1 specimen.
macra Cress. Oak creek, numerous specimens.
pruinosa Cress. Bill Williams fork, 7 specimens; San Bernardino ranch, 1; Tucson, 1.
strenua Cress. Oak creek, 1 specimen; Baboquivari, 1.
varipes Cress. Humphrey's Peak and Oak creek, several specimens in each locality.
vulgaris Cress. Humphrey's Peak and Oak creek, 1 specimen in each locality.
xanthoptera Cam. Oak creek, numerous specimens.
undetermined species. Oak creek, 3 specimens.
Pelopæus cementarius Drury. Congress Junction, Oak creek, Bill Williams fork, and San Bernardino ranch, numerous specimens in each locality.
servillei Lep. Congress Junction, Oak creek, Bill Williams fork, and Tucson, several specimens each.
Chalybion cæruleum Linn. Oak creek, 1 specimen; San Bernardino ranch, 3; Tucson, several specimens.
Chlorion cæruleum Drury. Congress Junction, Oak creek, Bill Williams fork, San Bernardino ranch, Tucson, and Baboquivari, numerous specimens in each locality.
Isodontia azteca Sauss. Oak creek, numerous specimens; Baboquivari, 2.
Sphex ashmeadi Fernald. Bill Williams fork, numerous specimens; Congress Junction, 1; San Bernardino ranch, 3; Tucson and Baboquivari, several specimens.
decolorata Blake. Oak creek and Baboquivari, numerous specimens in each locality.
decolorata Blake, var. baboquivari, several specimens.
ichneumonea Fabr. Oak creek, abundant specimens; Humphrey's Peak, at base, 1 specimen; Baboquivari, 3.
lucæ Sauss. Oak creek, 5 specimens; Tucson, 2.
pennsylvanica Linn. Oak creek, abundant specimens.
Sceliphron texanum Cress. Oak creek, 2 specimens.
Harpactopus abdominalis. Oak creek, 4 specimens.
rufiventris Cress. Oak creek, 7 specimens; San Bernardino ranch, 1 specimen.
Parasphex ferrugineus Fox. Congress Junction and Bill Williams fork, 3 specimens at each camp.
Prionyx striatus Smith. Bill Williams fork, 6 specimens; Baboquivari, 1.
thomæ Fabr. Oak creek, abundant specimens; Bill Williams fork, 2; San Bernardino ranch, 1; Baboquivari, several specimens.

Family LARRIDÆ.

Astata nevadica Cress. San Bernardino ranch, 2 specimens; Tuscon, 1.
nubecula Cress. Tucson, 1 specimen.
unicolor Say. Oak creek, 3 specimens; San Bernardino, 2.
Plenoculus propinquus Fox. Oak creek, 1 specimen.
Lyroda subita Say. Oak creek and San Bernardino ranch, 1 specimen in each locality.
Notogonia argentata Beauv. Oak creek, 1 specimen; Tucson, 1.
nigripennis occidentalis Vier. Bill Williams fork and San Bernardino ranch, 1 specimen in each locality; Baboquivari, 9.
Tachytes abdominalis Say. San Bernardino ranch, 1 specimen.
distinctus Smith. Bill Williams fork, 1 specimen.
fulviventris Cress. Congress Junction, 1 specimen; Oak creek, 11; Baboquivari, 3.
obscurus Cress. Bill Williams fork, 2 specimens; Oak creek, 5; Tucson, 3.
pepticus Say. Bill Williams fork, 3 specimens; San Bernardino ranch, 1; Baboquivari, numerous specimens.
spatulatus Fox. Oak creek, 5 specimens; Baboquivari, several.
Tachysphex propinquus Vier. Oak creek, 4 specimens.

Family BEMBECIDÆ.

Stizus godmani Cam. Bill Williams fork, 1 specimen; Oak creek, 2.
grandis Say. Tucson, 1 specimen.
unicinctus Say. Tucson, 1 specimen.
Bembex amœna Hdl. Oak creek, 5 specimens.
fasciata. Humphrey's Peak, at base, and Oak creek, numerous specimens each; San Bernardino ranch and Tucson, 1 each.
nubilipennis Cress. Oak creek and San Bernardino ranch, numerous specimens; Flagstaff and Tucson, 1 each.
sayi Cress. Bill Williams fork and Oak creek, 6 specimens in each locality; Congress Junction, 1; Baboquivari and Tucson, 3 each.
troglodytes Hdl. Bill Williams fork and Oak creek, 1 specimen in each locality.
u-scripta Fox. Bill Williams fork, 17 specimens.
Stictia pictifrons Smith. Oak creek, 20 specimens; Tucson, 1.
Microbembex monodonta Say. Bill Williams fork, Oak creek, Tucson, and Baboquivari, numerous specimens at each place.
pulchella Cress. Oak creek, 2 specimens.
ventralis Say. Oak creek, abundant; San Bernardino ranch, Congress Junction, and Baboquivari, 1 specimen in each locality.

Family NYSSONIDÆ.

Gorytes bipunctatus Say. Oak creek, 2 specimens.
costalis Cress. Oak creek, 1 specimen.
eximius Prov. Bill Williams fork, 1 specimen.
spilopterus Hdl. Congress Junction, 2 specimens; Oak creek and San Bernardino ranch, 1 each.
Paranysson texanus Cress. Tucson, 4 specimens.

Family TRYPOXYLONIDÆ.

Trypoxylon arizonensis Fox. Bill Williams fork, 4 specimens.
tridendatum Packard. Congress Junction, 2 specimens; San Bernardino ranch, 1; Tucson and Baboquivari, 8 each.

Family PHILANTHIDÆ.

Eucerceris canaliculatus Say. Bill Williams fork, 5 specimens; San Bernardino ranch, 3.
rubripes Cress. Oak creek, 15 specimens.
unicornis Patton. Oak creek, 6 specimens.
Cerceris acanthophilus V. & C. Congress Junction, 12 specimens; Bill Williams fork, 4; Oak creek, 6; Tucson, numerous.
biungulata Cress. Oak creek, 1 specimen.
ferruginior Viereck and Ckll. Oak creek, 5 specimens; Bill Williams fork, 1; Tucson, many.
fasciata Cress. Oak creek, 3 specimens.
femur-rubrum V. & C. Congress Junction, 1 specimen.
macrosticta V. & C. Oak creek, 2 specimens.
nasica V. & C. Oak creek, 2 specimens.
platyrhina V. & C. Oak creek, 1 specimen.
rinconis V. & C. Congress Junction, 1 specimen; Bill Williams fork, 6; Tucson, 4.
sexta Say. Humphrey's Peak, 1 specimen.
Philanthus albifrons Cress. Humphrey's Peak, 3 specimens; Oak creek, 2.
crabroniformis Smith. Congress Junction and Bill Williams fork, numerous specimens; Oak creek, 3; San Bernardino ranch, 1.
punctatus Say. Oak creek, numerous specimens; Bill Williams fork, Congress Junction, and Baboquivari, 1 specimen in each locality; Tucson, numerous specimens.
punctatus cockerelli Dunn. Oak creek, 3 specimens.
new species. Oak creek, 3 specimens.
Aphilanthops taurulus Ckll. Congress Junction, 10 specimens.
quadrinotatus Ashmead. Flagstaff, 1 specimen.
new species. Flagstaff, 1 specimen.

Family MIMESIDÆ.

Mimesa punctata Fox. Oak creek, 4 specimens.
unicincta Cress. Bill Williams fork, 1 specimen.

Family PEMPHREDONIDÆ.

Stigmus inordinatus Fox. Oak creek, 1 specimen.
Pemphredon inordinatus Say. Oak creek, 1 specimen.

Family CRABRONIDÆ.

Crabro bellus Cress. Oak creek, 1 specimen.
chrysarginus. Oak creek, 14 specimens.
decemmaculatus Say. Oak creek, 20 specimens.
dilectus Cress. Oak creek, 8 specimens.
imbutis Fox. Oak creek, 5 specimens.
interruptus St. Farg. Oak creek, 1 specimen.
nigrifrons Cress. Humphrey's Peak, 2 specimens.
odyneroides Cress. Oak creek, 5 specimens.
packardii Cress. Oak creek, 14 specimens.
Thyreopus coloradensis Packard. Humphrey's Peak, 2 specimens.

Family OXYBELIDÆ.

Oxybelus cornutus Say. Oak creek, 50 specimens.
emarginatus Say. Oak creek, 3 specimens; Bill Williams fork, 1.
lætus Say. Oak creek, 3 specimens.
4-notatus Say. Oak creek, 50 specimens.
Notoglossa emarginata Say. Oak creek and Tucson, 2 specimens each.

Family ANDRENIDÆ.

Agapostemon melliventris Cress. Congress Junction, 6 specimens.
nigricornis Fab. Congress Junction, 2 specimens; Tucson, 1.
tricolor St. Farg. Oak creek, numerous specimens.
texanus Cress. Bill Williams fork, Oak creek, Congress Junction, and Tucson, numerous specimens.

Family HALICTIDÆ.

Proteraner ranunculi Robt. Oak creek, 1 specimen.
Sphecodes, four undetermined species. Oak creek, three species; Congress Junction, one species.
Halictus ligatus Say. Oak creek, 10 specimens; Tucson, 4.
Colletes americana Cress. Humphrey's Peak, several specimens; Tucson and Baboquivari, 1 each.
consors Cress. Oak creek, 1 specimen; Baboquivari, 3; Tucson, 25.

Family PROSOPIDÆ.

Prosopis affinis Sm. Oak creek, several specimens.
ruidosensis Ckll. Oak creek, 1 specimen.
ten new and undetermined species, Oak creek and Humphrey's Peak, at base.

Family NOMIIDÆ.

Nomia foxii D. T. Oak creek, 2 specimens; Tucson, many specimens.
nevadensis Cress. San Bernardino ranch and Bill Williams fork, several specimens.

Family PANURGIDÆ.

Rhophitoides fimbriatus Cress. Humphrey's Peak, 1 specimen.
Halictoides oryx Vier. Oak creek, 1 specimen.
Pseudopanurgus rugosus Robt. Oak creek, 1 specimen.
Panurginus innuptus Ckll. Oak creek, 2 specimens.
perlævis Ckll. Oak creek, 1 specimen.
four new and undetermined species.
Perdita—seven new and undetermined species. Bill Williams fork and Oak creek.

Family ANTHOPHORIDÆ.

Centris atripes Mocsary. San Bernardino ranch, several specimens; Tucson and Baboquivari, 4 each.
morsei marginata Fox. San Bernardino ranch, 1 specimen.
rhodopus Ckll. Bill Williams fork, many specimens; Tucson and Baboquivari, several each.
Anthophora montana Cress. Oak creek, 1 specimen.
smithii Cress. Tucson, 2 specimens.
urbana Cress. Humphrey's Peak and Oak creek, several specimens each; Tucson, 2.

Family ANTHOPHORIDÆ.

Anthophora walshii Cress. Oak creek, several specimens.
two new species. Congress Junction.
Amegilla californica Cress. Oak creek, 2 specimens.
cleomis Ckll. Oak creek, 4 specimens.
Clisodon terminalis Cress. Humphrey's Peak and Oak creek, 1 specimen in each locality.
Dasiapis ochracea Ckll. Several specimens.
Diadasia australis Cress. Tucson, 1 specimen.
diminuta Cress. Oak creek and Bill Williams fork, several specimens in each locality.
enavata Cress. Baboquivari, 1 specimen.
rinconi Ckll. Bill Williams fork, Oak creek, and Baboquivari, 1 specimen each.
Tetralonia (Synhalonia) fuscotincta Ckll., new species. Oak creek, 1 specimen.
lippiæ Ckll. Oak creek, 3 specimens.
lippiæ, subspecies sublippiæ Ckll., new subspecies. Oak creek. 1 specimen.
Xenoglossa patricia angustior Ckll. Congress Junction, 1 specimen.
pruinosa Say. Oak creek, 1 specimen.
Melissodes agilis Cress. Oak creek, many specimens.
agilis, var. subagilis Ckll. Oak creek, numerous specimens.
aurigenia Cr. Oak creek, numerous specimens.
communis Cress., var. Oak creek and Bill Williams fork, numerous specimens.
confusa Cress. Humphrey's Peak, at base, several specimens.
duplocincta Ckll., new species. Bill Williams fork, numerous specimens; Tucson, 3.
epicharina Ckll., new species. Oak creek, 1 specimen.
var. *a*. Oak creek, 1 specimen.
gilensis Ckll. Oak creek and Bill Williams fork, several specimens; Tucson and Baboquivari, 2 each.
grindeliæ Ckll. Oak creek, numerous specimens.
var. Oak creek, 1 specimen.
hexacantha Ckll., new species. Oak creek, 1 specimen.
var. *a*. Oak creek, 2 specimens.
var. *b*. Oak creek, 1 specimen.
var. *c*. Oak creek, 1 specimen.
intermediella Ckll., var. San Bernardino ranch and Oak creek, numerous specimens.
menuacha Cress. Oak creek and Humphrey's Peak, at base, many specimens.
montana Cress. Oak creek, numerous specimens.
nigrosignata Ckll., new species. Oak creek, 1 specimen.
var. pallidisignata Ckll. Oak creek, 2 specimens.
pallidicincta Ckll. Bill Williams fork and Oak creek, several specimens.
prælauta Ckll., new species. Oak creek, 1 specimen.
semitristis Ckll., new species. Oak creek, 1 specimen.
tristis Ckll. Oak creek and Tucson, several specimens.
tenuitarsis Ckll., new species. Oak creek, 1 specimen.

Family MELECTIDÆ.

Nomada texana Cress. Oak creek, 1 specimen.
two new species. Bill Williams fork, 3 specimens.
Phileremus?, undetermined species. Oak creek, 1 specimen.
Ericrocis lata Cress. Bill Williams fork, numerous specimens.
Epeolus lunatus Say. Oak creek, numerous specimens.
occidentalis Cress. Oak creek and San Bernardino, numerous specimens.
three undetermined species. Oak creek.
Triepeolus verbesinæ Ckll. Bill Williams fork, 1 specimen.
five new and undetermined species. Oak creek.

Family STELIDÆ.

Stelis rudbeckiana Ckll. Oak creek, numerous specimens.
Ceolioxys alternata Say. Oak creek, numerous specimens.
menthæ Ckll. Bill Williams fork, 1 specimen; Tucson, 25.
modesta Sm. Oak creek, 2 specimens.
octodentata Say. Oak creek, numerous specimens; Tucson, 2.
porteræ Ckll. Oak creek, 2 specimens.
ribis Ckll. Oak creek, 3 specimens.
rufitarsus Sm. Oak creek, 1 specimen.
sayi Robt. Oak creek, 2 specimens.
texana Cress. Oak creek, 2 specimens.
two undetermined species. Oak creek, several specimens each.

Family MEGACHILIDÆ.

Osmia mandibularis Cress., var. Humphrey's Peak, at base, 1 specimen.
undetermined species. Oak creek, several specimens.
Heriades gracilior Ckll. Oak creek, 4 specimens.
Ashmeadiella bigeloviæ Ckll. Bill Williams fork, numerous specimens.
meliloti Ckll. Oak creek, 10 specimens.
rotundiceps Cress. Oak creek, 4 specimens.
Anthidium emarginatum Say. Humphrey's Peak and Oak creek, several specimens.
maculifrons Sm. Oak creek, 1 specimen; Tucson, several.
maculosum Cress. Oak creek, Humphrey's Peak, at base, and Tucson, several specimens each.
Megachile agustini Ckll. Oak creek, numerous specimens.
avara Cress. Oak creek, numerous specimens.
brevis Say. San Bernardino ranch, numerous specimens.
lanuginosa Sm. (= brevis Say.) Oak creek.
cleomia Ckll. Oak creek, 3 specimens.
comata Cress. Oak creek, 3 specimens.
fidelis Cress. Oak creek, several specimens.
near inimica Cress. Oak creek, several specimens.
latimana. Oak creek, 3 specimens.
optiva Cress? Oak creek, several specimens.
perbrevis Cress. Oak creek, several specimens.
pereximia Ckll. Bill Williams fork, 1 specimen.
pugnata Say. Oak creek, numerous specimens.
relativa Cress. Oak creek, several specimens.

Family MEGACHILIDÆ.

Megachile texana Cress. Oak creek, San Bernardino ranch, and Bill Williams fork, several specimens.

vidua, race monaidum Ckll. One specimen.

Ceratina, undetermined species. Oak creek and Bill Williams fork, 1 specimen each.

undetermined species. Oak creek, 3 specimens.

Family XYLOCOPIDÆ.

Xylocopa californica Cress. Oak creek, San Bernardino ranch, Baboquivari, and Tucson, many specimens in each locality.

micans. Oak creek, many specimens.

new species. Bill Williams fork, Tucson, and Baboquivari, several specimens each.

undetermined species. Oak creek, 4 specimens.

Family BOMBIDÆ.

Protoxæa gloriosa Fox. San Bernardino ranch, 10 specimens.

Oxæa tristis Gribodo. San Bernardino ranch, 8 specimens.

Psithurus insularis Sm. Oak creek, 1 specimen.

Bombus bifarius Cress. Oak creek and Humphrey's Peak, at base, 1 specimen each.

dorsalis Cress. Oak creek, 5 specimens.

flavifrons Cress. Humphrey's Peak, several specimens.

howardi Cress. Oak creek and Humphrey's Peak, several specimens.

morrisonii Cress. Oak creek, many specimens.

sonorus Say. San Bernardino ranch and Tucson, many specimens; Baboquivari, 1 specimen.

Family APIDÆ.

Apis mellifica Linn. Abundant at all the camps.

SUMMARY OF FAMILIES AND SPECIES OF HYMENOPTERA.

Tenthredinidæ	8	Sphecidæ	29
Siricidæ	2	Larridæ	14
Evaniidæ	1	Bembecidæ	13
Ichneumonidæ	29	Nyssonidæ	5
Braconidæ	12	Trypoxylonidæ	2
Encyrtidæ	1	Philanthidæ	21
Perilampidæ	3	Mimesidæ	2
Chalcididæ	7	Pemphredonidæ	2
Figitidæ	2	Crabronidæ	10
Scelionidæ	1	Oxybelidæ	5
Diapriidæ	1	Andrenidæ	4
Formicidæ	6	Halictidæ	8
Dorylidæ	1	Prosopidæ	12
Myrmicidæ	4	Nomiidæ	1
Mutillidæ	15	Panurgidæ	16
Tiphiidæ	3	Anthophoridæ	47
Scoliidæ	8	Melectidæ	16
Myzinidæ	3	Stelidæ	12
Chrysididæ	8	Megachilidæ	27
Eumenidæ	19	Xylocopidæ	4
Vespidæ	7	Bombidæ	9
Ceropalidæ	34	Apidæ	1

Totals: Families, 44; species, 435.

RESULTS OF THE ENTOMOLOGICAL COLLECTING EXPEDITION

Of the University of Kansas to Pima County, Arizona, in June and July, 1906.

By F. H. SNOW, University of Kansas, Lawrence.

This paper also includes Arizona material of former expeditions not previously identified, the location being given in each instance.

THE twenty-fifth collecting expedition in charge of the writer spent nine days in camp on the ranch of Mr. Thomas C. Kurtz, one and a half miles north of the railroad station at Tucson. The members of the party, in addition to the director, were Leverett A. Adams, for several years assistant in the department of zoology in the University of Kansas, now a member of the faculty of the State Normal School, at Greeley, Colorado, and S. E. Crumb, a student of the junior class. In the vicinity of this camp 3214 specimens were collected during the nine days, of which more than 2000 belong to the order of Hymenoptera. On July 3 the collecting party was increased by the arrival of Mr. Eugene Smyth, of Topeka, who had accompanied the writer on four preceding expeditions. On July 4 we started by wagon for Sycamore canyon, also called Brown canyon, in the southern portion of the Baboquivari mountains, and located our camp at a distance of sixty miles southwest of Tucson. This entire region is a typical desert area, and we found no small difficulty in obtaining a suitable supply of drinking water. At this second camp we collected insects for three weeks—from July 6 to 26—securing over 11,000 specimens, which, added to the Tucson material, made a total of 15,000 specimens as the result of the entire period of less than five weeks of actual work. At the second camp the Coleoptera took first place in the number of species and specimens collected, amounting to nearly one-half of the entire material. In regard to the scientific value of this material, Mr. Charles Liebeck, of Philadelphia, to whom I submitted many species of the Coleoptera which I was unable to identify from our previous collections, made the following statement: "The usual handicap, lack of Mexican material and synoptical tables in the Biologia Centrali-Americana, has hampered me more with this lot than with any other I have ever handled, due to the great number of apparent new species; and I must say that your 1906 catch certainly shows the finest lot of species I ever handled in one consignment.

Arizona is evidently a very rich field, and many possibilities are yet in store. I think it safe to assert that nearly all of those species (nearly sixty in number) marked simply as 'undetermined' are undescribed, and I can most surely state that they are not, or have not yet been, included in the United States fauna."

One of the most interesting captures among the Coleoptera at our second camp, was a limited number of specimens of the rare *Amblychila baroni* Rivers, which was found among the rocks near the summit of the mountain ridges between which our camp was situated—from 400 to 500 feet above the bottom of the canyon.

The altitude of the Baboquivari camp is 3750 feet above sea-level. The vegetation is largely of the usual type of the arid regions of the United States—many forms of cactus, yucca, agave or meschal, mesquite, and greasewood—and in the bottom of the canyon are trees of considerable size of the sycamore, walnut, and live oak. There were three quite copious thunder-showers during the three weeks of our stay, but in no case was there sufficient precipitation to cause the slightest run of water in the dry bed of the canyon. My hearty appreciation is hereby expressed of the most efficient services of my associates, Messrs. Adams, Crumb, and Smyth. Mr. Adams, in addition to his energetic work in collecting insects, also made a collection of birds, numbering 34 species, a list of which is contributed by him to the program for this meeting of the Academy.

I.—LIST OF COLEOPTERA.

For valuable services in the determination of species I am indebted to Mr. Charles Liebeck, of Philadelphia, and Mr. H. C. Fall, of Pasadena, Cal. I am also under obligations to Mr. A. B. Wolcott, of Chicago, for efficient aid in the family Cleridæ.

The numbers are those of Henshaw's lists.

When no locality is appended, the Baboquivari mountains are intended.

Family CICINDELIDÆ.

Amblychila baroni Rivers.
12 Tetracha carolina Linn. Tucson.
57 Cicindela lemniscata Lec.
wickhami W. Horn.
64*b* 16-punctata Kl.

Family CARABIDÆ.

139 Calosoma semilæve Lec.
213 Pasimachus mexicanus Gray.
218 punctulatus Hald.
220 Scarites subterraneus Fab., var. californicus Lec. Tucson; San Bernardino ranch, 1905.

Family CARABIDÆ.

275 Clivina bipustulata Fab. San Bernardino ranch, 1905.
345 Bembidium lugubre Lec.
timidum Lec.
454 Tachys vivax Lec.
557 Pterostichus subcordatus Lec. San Bernardino ranch, 1905.
672 Amara californica Dej.
683 musculus Say.
Calathus, new species near opaculus Lec.
746? behrensii Mann.
771 Platynus brunneomarginatus Mann., var. bicoloratus Germ.
772 extensicollis Say, var. San Bernardino ranch, 1905.
two new species?.
866 Tetragonoderus fasciatus Hald.
875 Lebia majuscula Chd.
876 atriceps Lec.
882 viridis Say.
916 Axinopalpus fusciceps Lec.
931 Plochionus timidus Hald.
940 Cymindis cribricollis Dej.
960 Helluomorpha texana Lec.
981 ferruginea Lec.
984 Brachynus fidelis Lec.
986 carinulatus Motz.
two undetermined species.
981 Chlænius ruficauda Chd.
1008 Chlænius leucoscelis Chev.
new species.
1047 Oodes elegans Lec.
1057 Pœsoma setosum Lec.
1070 Discoderus robustus Horn.
1071 amœnus Lec.
1112 Harpalus clandestinus Lec.
1134 Selenophorus palliatus Fab.
1125 pedicularius Dej.
1140 Stenolophus conjunctus Say.
1179 Anisodactylus opaculus Lec. Tucson.
1192 arizonæ Casey.
new species.
1214 Pseudomorpha angustata Horn.

Family DYTISCIDÆ.

1246 Laccophilus pictus Lap. At both camps.
1251 mexicanus Aube.
truncatus Mann. Tucson.
1306 Deronectes striatellus Lec.
æquinachialis Clark.
1413 Agabus lugens Lec.
1458 Rhantus flavogriseus Cr. San Bernardino ranch, 1905.
1459 binotatus Harr.
1461 atricolor Aube.
1495a Thermonectes nigrofasciatus Aube.
1497 marmoratus Hope. At both camps.

Family GYRINIDÆ.

1515 Gyrinus plicifer Lec. At both camps.
1533 Dineutes sublineatus Chev.

Family HYDROPHILIDÆ.

1587 Hydrophilus insularis Lap. Tucson.
1588 Tropisternus limbalis Lec.
1594 ellipticus Lec. Tucson.
1600 Berosus punctatissimus Lec.
1605 styliferus Horn.
1610 immaculatas Zimm. San Bernardino ranch, 1905.
1634 Philhydrus diffusus Lec.

Family SILPHIDÆ.

1705 Silpha truncata Say.

Family STAPHYLINIDÆ.

2059 Aleochara nitida Gray.
2164 Philonthus semiruber Horn.
2182 alumnus Er., var. atriceps Fauvel. San Bernardino ranch, 1905.
2495 Cryptobium pimerianum Lec. San Bernardino ranch, 1905.
2701 Osorius planifrons Lec.
Oxytelus, undetermined species.

Family SCAPHIDIIDÆ.

2980 Scaphisoma castaneum Mots.

Family PHALACRIDÆ.

Eustilbus viduus Casey. San Bernardino ranch, 1905.

Family COCCINELLIDÆ.

3046 Hippodamia convergens Guer. At both camps.
3065*a* Olla abdominalis Say. At both camps.
3083 Exochomus marginipennis Lec.
arizonicus Casey. Tucson.
9900 Thalassa montezumæ Muls. Tucson.
Hyperaspis centralis Muls.
undetermined species.
Scymnus virginalis Wickham.

Family ENDOMYCHIDÆ.

Epipocus subcostatus Gorham.

Family EROTYLIDÆ.

3219 Ischyrus 4-punctatus Oliv.

Family CRYPTOPHAGIDÆ.

Anobocœlus championi Sharp.

Family DERMESTIDÆ.

3418 Dermestes marmoratus Say.
3420 caninus Germ.
3423 carnivorus Fab.
3426 elongatus Lec. Tucson.
Cryptorhopalum obesulum Casey.

Family HISTERIDÆ.

2457 Holoepta cacti Lec. Tucson.
2497 Hister cunnosus Er.
undetermined species near abbreviatus Fab.
2516 vernus Say.
2532 lubricans Casey.
2576 Saprinus pectoralis Lec.
2605 neglectus Mars.
2608 lubricus Lec.
2610 fimbriatus Lec.

Family TROGOSITIDÆ.

2633 Trogosita virescens Fab.
2641 Tenebriodes sinuata Lec.
Hesperobænus yuccæ Sz.

Family PARNIDÆ.

2920 Dryops productus Lec. At both camps.

Family ELATERIDÆ.

4064 Anelastes drurii Kirby.
Adelocera mexicana Candize.
4090 Chalcolepidius smaragdinus Lec.
10085 behrensi Cand.
tartarus Fall.
snowi Casey. New species. Bill Williams fork, 1903.
idoneus Casey. New species. Bill Williams fork, 1903.
arizonicus Casey. New species. Bill Williams fork, 1903.
abdominalis Casey. New species. Bill Williams fork, 1903.
simulans Casey. New species. Bill Williams fork, 1903.
rectus Casey. New species. San Bernardino ranch, 1905.
ostentus Casey. New species. Congress Junction and Bill Williams fork, 1903.
[The above seven new species of Chalcolepidius are described from my material in the *Canadian Entomologist* for February, 1907.]
4092 Alaus lusciosus Hope.
4113 Cardiophorus tenebrosus Lec.
aptopoides Cand.
Horiatonotus, new species.
4128 simplex Lec.
4135? Katheeopus præditus Horn.
4136 parcus Horn.
4137 dispersus Horn.
new species.
undetermined species.
Aptopus spadiceus?
Anchastus, undetermined species.
4181 Monocrepidius lividus De G.
4183 vespertinus Fab.

Family ELATERIDÆ.

4187 Monocrepidius lathoides Lec.
4188 sordidus Lec.
elegans. San Bernardino ranch, 1905.
4194 Dicrepidius corvinus Cand.
Ludius peninsularis Champ.?
42772 hepaticus Germ.
Agriotes, undetermined species.
4306 Melanotus macer Lec.
4322 fissilis Say.
4323 communis Gyll.

Family BUPRESTIDÆ.

Agæocera, undetermined species.
4575*a* Psiloptera webbii Lec.
Dicerca, undetermined species. Tucson.
4636 Chrysobothris octocola Lec.
4656 gemmata Lec.
10085 merkelii Horn.
4672 Thrincopyge ambiens Lec.
4675 Polycesta velasco L. & G.
Acmæodera conoidea Fall.
4708 4-vittata Horn.
10107 delumbis Horn.
undetermined species. San Bernardino ranch, 1905.
4737 Agrilus addendus Cr.
4749 obolinus Lec.
undetermined species.

Family LAMPYRIDÆ.

4768 Lycus cruentus Lec.
4769 fernandezii Duges.
4772 Lycostomus loripes Chev.
4817 Pyropyga fenestralis Melsh. Tucson.
4845 Microphotus dilatatus Lec.
4862 Spathizus bicolor Lec.
Polemius, undetermined species.

Family MALACHIDÆ.

5013 Collops vittatus Say.
regularis Gorh. San Bernardino ranch, 1905.
5061 Attalus rufiventris Horn.
5077 Pristoscelis convergens Lec. San Bernardino ranch, 1905.

Family CLERIDÆ.

5131 Cymatodera puncticollis Bland.
5134 cylindricollis Chev.
5135 brunnea Mels.
5142 morosa Lec.
5151 ovipennis Lec.
peninsularis Schaeffer.

Family CLERIDÆ.

Cymatodera latefascia Schaeffer.
umbrina Fall.
subsimilis Wolcott. New species.
5164 Clerus spinolæ Lec.
Hydrocena cincta Spin.
5230 Necrobia rufipes Fab. Tucson.

Family PTINIDÆ.

10150 Ctenobium cinereum Horn.
5338 Sinoxylon simplex Horn.
5340 sericans Lec.
5354 Amphicerus fortis Lec.

Family SCARABÆIDÆ.

5432a Canthon corvinus Horn.
5437 indigaceus Lec.
5445 Copris remotus Lec.
5448 carolina Linn.
5461 Onthophagus velutinus Horn.
new species.
Atænius haroldi Steinbeil. San Bernardino ranch, 1905.
5529 Aphodius vittatus Say.
5581 Ochodæus biarmatus Lec.
5617 Trox punctatus Germ. Both camps.
5701 Diplotaxis popino Casey.
three undetermined species.
near tristis Kirby.
5713 mœrens Lec.
5722 atratula Lec.
Lachnosterna labidens Schaeffer?.
10261 vetula Horn.
10270 lenis Horn. San Bernardino ranch, 1905.
5804 Phytalus debilis Horn.
5809 Listrochelus scoparius Lec. B. and T.
5812 mucoreus Lec.
5832 Anomala centralis Lec.
5846 Pelidnota lugubris Lec.
5859 Cyclocephala longula Lec.
5862 villosa Burm.
comata Bates.
5865 dimidiata Burm.
5870 Ligyrus ruginasus Lec.
5891 Phileurus illatus Lec.
5893 Allorhina mutabilis Gory.
Gymnetis impius Fall.
5898 Euphoria verticalis Horn.
5903 devulsa Horn.
5907 leucographa Gory.
holochloris Fab.
5919 Cremastochilus ineptus Horn.
mexicanus Schaum.

Family CERAMBYCIDÆ.

5953 Mallodon dasystomus Say.
5955 serrulatus Lec.
5957 Derobrachus geminatus Lec.
6026 Hypexilis pallida Horn.
6032 Axestinus obscurus Lec.
6036 Osmidus guttatus Lec.
Peribacum reticolle Bates.
6039 Eburia ulkei Bland.
undetermined species.
6055 Elaphidion alienum Lec.
6059 inerne Newm.
6067 tenue Lec.
Aneflus, new species.
6076 protensus Lec.
6078 Eustroma validum Lec.
6105 Rhopalophora longipes Say.
6111 Elytroleptus ignitus Lec.
6115 Callichroma plicatum Lec.
6121 Stenaspis verticalis Serv.
6122 solitaria Say.
Metaleptus, new species.
6126 Tragidion annulatum Lec.
6135 Æthecerus latecinctus Horn.
6145 Oxoplus jocosus Horn.
10297 Crossidius blandi Casey. San Bernardino ranch, 1905.
6160 Ischnocnemis bivittatus Dup.
6370 Monilema appressum Lec.
6372 gigas Lec. Both camps.
6372 semipunctatum Lec.
6410 Cœnopœus palmeri Lec.
Leptostylus yuccæ Fall. New species. San Bernardino ranch, 1905.
6433 Dectes spinosus Say. Tucson.
6471 Ataxia crypta Say, var.
10324 Peritapnia fabra Horn.

Family CHRYSOMELIDÆ.

Lema longipennis Linell.
6571 balteata Lec.
6582 Euryscopa lecontei Cr. Both camps.
parvula Jac.
6584 Coscinoptera æneipennis Lec.
6589 mucorea Lec.
6593 Megalostomis pyropyga Lac.
6594 major Cr.
6596 Babia 4-guttata Oliv.
6596*b* tetraspilota Lec.
6597 Saxinis apicalis Lec.
scutellaris Schaeffer. New species. San Bernardino ranch, 1905. Described in the Bulletin Mus. Brooklyn Inst. Arts and Sciences, October, 1906.
10346 sonorensis Jac.

Family CHRYSOMELIDÆ.

6600 Urodera crucifera Lac.
Chlamys arizonensis Linell.
6605 Exema comspersa Mann.
Cryptocephalus simulans Schaeffer. San Bernardino ranch, 1905.
simulans Schaefer, var.
basalis Suffr., var.
6651 Griburius montezumæ Suffr.
6690 Pachybrachys atomarius Melsh.
new species.
undet. species.
6747b Paria 4-notata Say.
Nodonota arizonica Schaeffer. New species. San Bernardino ranch, 1905. Described in the Bulletin Mus. Brooklyn Inst. Arts and Sciences, October, 1906.
10356 Metachroma aterrimum Horn. San Bernardino ranch, 1905.
6774 Colaspis brunnea Fab., var. Tucson.
6787 Doryphora lineolata Stal.
6792 haldemani Rog.
6794 rubiginosa Rog.
6797 Zygogramma opifer Stal.
6798 continua Lec.
6811 dislocata Rog.
6813 tortuosa Rog.
6816 multiguttata Stal.
clathrata Jac.
new species.
Plagiodera purpurea Linell.
6836 Lina arizonæ Cr. Tucson.
Androlyperus, new species.
Andrector ruficornis Oliv. Tucson.
10383 Scelolyperus flaviceps Horn.
Triarius, new species, or possibly a color variety of T. lividus Lec.
6861 Diabrotica 12-punctata Oliv. Both camps.
6883 balteata Lec. Tucson.
two undetermined species.
Cneorane mexicana? Jacoby.
6916a Monoxia angularis Lec.
6933 Œdionychis lugens Lec., var.
10410 tenuilineata Horn.
extrema Harold.
two undetermined species.
6954 Disonycha abbreviata Melsh.
6962 Haltica carinata Germ., var. or perhaps a new species.
6966 obliterata Lec.
undetermined species.
7063 Microrhopala rubrolineata Mann.
Brachycoryne pumila Boh.
7098 Cassida bivittata Say.
undetermined species. San Bernardino ranch, 1905.
7106 Coptocycla lecontei Cr.
profligata Boh.

Family BRUCHIDÆ.

7137 Bruchus prosopis Lec. Tucson.
7149 amicus Horn. Both camps.

Family TENEBRIONIDÆ.

7183 Eurymetopon emarginatum Casey.
7200 Epitragus submetallicus Lec.
7204 pruinosus Horn.
7219 Zopherus tristis Lec.
7238 Cryptoglossa verrucosa Lec. Tucson.
7243 Centrioptera variolosa Horn. Both camps.
7251 Ologyptus anastomosis Say.
7255 Asida mancipata Horn.
7268 parallela Lec. Tucson.
7284*a* rimata Lec.
7307 Eusattus reticulatus Say.
7322 Eleodes carbonaria Say.
forin soror Lec. San Bernardino ranch, 1905.
7324 quadricollis Esch. Both camps.
7325 humeralis Lec.
7327 extricata Say.
7331 longicollis Lec.
10560 wickhami Horn.
7339 nigrina Lec.
7360 subnitens Lec.
dissimilis, var. nevadensis Blaisdell.
new species.
7379 Argoporus costipennis Lec.
10568 alutacea Casey.
7392 Nyctobates subnitens Horn.
7552 Notibius gagates Horn.
7517 Platydeina inquilinum Linell.
undetermined species, near ruficolle Lap.
10631 Strongylium atrum Champ.

Family CISTELIDÆ.

10647 Hymenorus grandicollis Champ.
10653 prolixus Casey.
10678 Telesicles caudatus Champ. San Bernardino ranch, 1905.

Family LAGRIIDÆ.

Statira defecta Schaeffer.
huachuchæ Schaeffer.

Family ŒDEMERIDÆ.

7739 Oxacis cana Lec.
7743 sericea Horn. San Bernardino ranch, 1905.

Family MORDELLIDÆ.

7760 Diclidia lætula Lec.
marginalis Say. San Bernardino ranch, 1905.
7847 Mordellistena, new species.

Family ANTHICIDÆ.

Stereopalpus impressicollis Casey?. San Bernardino ranch, 1905.
Notoxus curvitrichus Casey.
7938 Anthicus sturmii Laf.
7948 confinis Lec. Tucson.

Family MELOIDÆ.

8058 Macrobasis pupurea Horn.
8066 lauta Horn.
8067 teniella Lec.
8069 segmentata Say.
10733 tenuilineata Horn.
8089 insignia Horn. San Bernardino ranch, 1905.
8991 Epicauta pardalis Lec. Both camps.
alastor Skinner.
undetermined species.
8110 Pyrota postica Lec.
10748 Tegrodera latecincta Horn. Tucson.

Family RHIPIPHORIDÆ.

8183 Myodites scaber Lec.

Family OTIORHYNCHIDÆ.

8249 Eupagoderes sordidus Lec.
8250 argentatus Lec. Tucson.
8315 Pandeletejus cinereus Horn.
8338 Coleocerus marmoratus Horn.

Family CURCULIONIDÆ.

8373 Apion sordidum Smith.
8500 Lixus perforatus Lec.
10860 Dinocleus denticollis Casey.
8571 Endalus limatulus Gyll. San Bernardino ranch, 1905.
8603 Otidocephalus vittatus Horn.
8607 chevrolatii Horn.
8654 Anthonomus hirtus Lec. Tucson.
11056 Tychius hispidus Casey.
8749 Chalcodermus spinifer Horn.
8760 Acalles prosus Lec.
Cryptorhynchus, undetermined species.
Zascelis oblonga.
8807 Zygops seminiveus Lec.
8868 Baris strenua Lec. San Bernardino ranch, 1905.
8886 Pseudobaris farcta Lec.
Stictobaris, new species. San Bernardino ranch, 1905.

Family CALANDRIDÆ.

8973 Scyphophorus acupunctatus Gyll.
undetermined species.
Calandrid, undetermined genus and species, near Nyssonotus.
Sphenophorus, undetermined species, near oblitus Lec. San Bernardino ranch, 1905.
undetermined species, near mormon[illegible] Bernardino ranch, 1905.

Family ANTHRIBIDÆ.

9221? Cratoparis lunatus Fab.
undetermined species.

SUMMARY OF FAMILIES AND SPECIES OF COLEOPTERA.

Cicindelidæ	5	Malachidæ	4
Carabidæ	45	Cleridæ	12
Dytiscidæ	11	Ptinidæ	4
Gyrinidæ	2	Scarabæidæ	39
Hydrophilidæ	6	Cerambycidæ	34
Silphidæ	1	Chrysomelidæ	63
Staphylinidæ	7	Bruchidæ	2
Scaphidiidæ	1	Tenebrionidæ	29
Phalacridæ	1	Cistelidæ	3
Coccinellidæ	8	Lagriidæ	2
Endomychidæ	1	Œdemeridæ	2
Erotylidæ	1	Mordellidæ	3
Cryptophagidæ	1	Anthicidæ	4
Dermestidæ	5	Meloidæ	11
Histeridæ	9	Rhipiphoridæ	1
Trogositidæ	3	Otiorhynchidæ	4
Parnidæ	1	Curculionidæ	16
Elateridæ	35	Calandridæ	5
Buprestidæ	15	Anthribidæ	2
Lampyridæ	7		

Totals: Families, 39; species, 395.

II.—LIST OF LEPIDOPTERA.

My grateful acknowledgments for assistance in the determination of species in this order are hereby tendered to Dr. Henry Skinner, Dr. H. G. Dyar, Prof. John B. Smith, Dr. W. G. Dietz, Mr. W. D. Kearfott, and Mr. G. W. Taylor.

The locality is the Baboquivari, mountains unless otherwise stated.

Numbers according to Smith's check-list of 1903.

Family NYMPHALIDÆ.

103 Melitæa chara Edw.
113 definita Aaron.
137*a* Synchloe crocale Edw.
158 Pyrameis cardui Linn.
160*a* Junonia negra Feld.
182*a* Heterochroa californica Butl.
185 Apatura leilia Edw.
205 Neonympha rubricata Edw.

Family LIBYTHEIDÆ.

1 Libythea bachmani Kirtl.

Family Erycinidæ.

257 Lemonias duryi Edw.
261 palmerii Edw.
265 Calephelis australis Edw.

Family Lycænidæ.

293 Thecla melinus Hbn.
308 blenina Hew.
311 leda Edw.
387 Lycæna isola Reak. Tucson.
388 gyas Edw. Tucson.
393 exilis Edw.
394 marina Reak.

Family Papilionidæ.

423 Catopsilia eubule Linn.
433 Colias cæsonia Stoll.
438 Terias mexicana Bdv.
454 nicippe Cram. Tucson.
469 Papilio philenor Linn.
478 bairdii Edw.
485 daunus Bdv.

Family Hesperidæ.

495 Copæodes waco Edw.
495a , procris Edw.
604 Amblyscirtes ænus Edw.
620 Pyrgus nessus Edw.
occidentalis Skinner.
640 Nisoniades clitus Edw.
645 Systasea pulverulenta Feld.
649 Pholisora catullus Fabr.
652 ceos Edw.
661 Eudamus pylades Scudd.
668 hippalus Edw.
687 Heteropia melon Gdm. and Salv., var. arizonensis Skinner.

Family Sphingidæ.

725 Amphion nessus Cram.
729 Deilephila lineata Fabr.

Family Saturniidæ.

814 Agapema galbina Clem.

Family Ceratocampidæ.

829 Adelocephala heilgbrodtii Harv.

Family Syntomidæ.

Syntomeida benta Skinner. New species. Described in *Entomological News*, December, 1906.
866 Ctenucha venosa Wlk. Tucson.

Family ARCTIIDÆ.

921 Ptychoglene coccinea Hy. Edw.
950 Estigmene acræa Dru.
1005 Euchætias murina Stretch.
bolteri Stretch. San Bernardino ranch, 1905.
1016 Pygarctia elegans Stretch.
1038 Eupseudosoma involutum Sepp. San Bernardino ranch, 1905.
1041 Calidota zella Dyar.

Family AGARISTIDÆ.

1059 Alypiodes bimaculata H.-S.
1066 Copidryas gloveri G. & R.

Family NOCTUIDÆ.

Cyathissa quadrata Sm. New species.
1260 Perigæa albolabes Grt.
1359 Hadena indirecta Grt. Oak Creek canyon, 1904.
1372 smaragdina Neum.
1453 Laphygma flavimaculata Harv.
Aleptina flavomedia Sm. New species.
1642 Peridroma rudens Harv.
2148 Trichoclea decepta Grt. San Bernardino ranch, 1905.
2149 nova Sm. San Bernardino ranch, 1905.
2161 Leucania unipunctata Harv.
2478 Trileuca buxea Grt. Tucson.
2542 Schinia sexplagiata Sm. San Bernardino ranch, 1905.
2548 unimaculata Sm.
2563 tertia Grt. San Bernardino ranch.
accessa Smith. New species. San Bernardino ranch, 1905.
2645 Oxycnemis advena Grt.
2660 Neumœgenia poetica Grt.
2661 Narthecophora pulverea Sm. Tucson.
2688 Plusiodonta compressipalpis Gn.
Ogdoconta altura Barnes.
2811 Pleonectyptera habitalis Wlk.
new, species.
2842 Erastria propera Grt.
2852 Azenia edentata Grt.
2863 Xanthoptera clausula Grt.
2864 semiflava Gn.
2869 Thalpochares daria Druce.
2871 fortunata Grt.
2872 perita Grt.
2877 Tripudia opipara Hy. Edw.
2905 Acontia expolita Grt.
2912 biplaga Gn.
2916 quadriplaga Sm.
2924 elegantula Harv. Tucson.
2933 libedis Sm.
alata Sm.
2937 Fruva fasciatella Grt.

Family NOCTUIDÆ.

2946 Spragueia plumbifimbriata Grote.
2950 funeralis Grote.
2953 tortricina Zeller. Taken also at Tucson.
2971 Parora texana Sm.
Isogona segura Barnes.
3003 Euclidia dyari Sm.
3008 Melipotis nigrescens G. & R.
3009 pallescens G. & R.
3010 perlæta Hy. Edw.
3019 Cirrhobolina deducta Morr.
3020 mexicana Behr.
3021 vulpina Hy. Edw.
3191 Heteranassa fraterna Sm.
3192 minor Sm.
3202 Yrias clientis Grt.
3204 volucris Grt.
3205 repentis Grt.
strigalis Smith.
3235 Erebus odora Linn.

Family NOTODONTIDÆ.

Notodonta, new species.
Dasylophia zethus Druce. San Bernardino ranch, 1905. New to United States.
3396 Heterocampa lunata Hy. Edw. San Bernardino ranch, 1905.
pyrrha Druce.
3428 Gluphisia septentrionalis Wlk. San Bernardino ranch, 1905.
Notela jaliscana Schaus.
Hapigia xolotl Druce.

Family LIPARIDÆ.

Archylus tener Druce.

Family GEOMETRIDÆ.

3610 Coryphista meadii Pack. Oak Creek canyon, 1904.
3619 Phylace luteolata Hulst. Oak Creek canyon, 1904.
3638 Zenophleps lignicolorata Pack. Oak Creek canyon, 1904.
3680 Hydriomena mirabilata Grt. Oak Creek canyon, 1904.
3690 Cœnocalpe aurata Grt. Oak Creek canyon, 1904.
3691 magnoliata Gn. Oak Creek canyon, 1904.
3697 polygrammata Hulst. San Bernardino ranch, 1905.
3760 Cosymbia pannaria Gn. San Bernarnino ranch, 1905.
3796 Eois demissaria Hbn. San Bernardino ranch, 1905.
3805 ossularia Hbn. Taken also at San Bernardino ranch, 1905.
3808 balistaria Gn. San Bernardino ranch, 1905.
3809 rufescens Hulst. San Bernardino ranch, 1905.
3838 Chlorochlamys chloroleucaria Gn. San Bernardino ranch, 1905.
3857 Synchlora denticulata Walker. San Bernardino ranch, 1905.
3878 Fernaldella fimetaria G. & R.
3893 Chloraspilates bicoloraria Pack. San Bernardino ranch, 1905.
3916 Deilinia behrensaria Hulst., var? Oak Creek canyon, 1904; also, at San Bernardino ranch, 1905.

Family GEOMETRIDÆ.

3929 Sciagraphia punctolineata Pack.
3948 Macaria s-signata Pack. Taken also at San Bernardino ranch, 1905.
near mendicata Hulst. San Bernardino ranch, 1905.
4081 Alcis obliquaria Grote. San Bernardino ranch, 1905.
4085 haydenata Pack. Oak Creek canyon, 1904.
4096 Meris alticola Hulst. Oak Creek canyon, 1904.
4102 Tornos scolopacinarius Green. Tucson.
4103 abjectarius Hulst.
4106 Glaucina pygmeolaria Grt.
puellaria Dyar.
Sabulodes, undetermined species. San Bernardino ranch, 1905.
4276 Metanema vanusaria Strck. Oak Creek canyon, 1904.
4289 Stenispilates meskearia Pack. San Bernardino ranch, 1905.

Family LIMACODIDÆ.

4419 Euclea pænulata Clem.?
incisa Harr. San Bernardino ranch, 1905.
4436 Prolimacodes trigona Hy. Edw.
Limacodes oropeso.

Family MEGALOPYGIDÆ.

4448 Megalopyge opercularis S. & A.

Family PYROMORPHIDÆ.

4458 Triprocris fusca Hy. Edw.
4461 constans Hy. Edw.

Family THYRIDÆ.

Dysodia, new species.

Family PYRALIDÆ.

4629 Glaphyria reluctalis Hulst.
4634 Symphysa eripalis Grt. San Bernardino ranch, 1905.
simplicialis Kearfott. New species. San Bernardino ranch, 1905. Described in *Entomological News*, January, 1907.
4651 Diastictis fracturalis Zell.
4680 Agathodes monstralis Gn.
4692 Hellula undalis Fab. San Bernardino ranch, 1905.
4694 Terastia metriculosalis Gn.
4718 Loxostege helvialis Wlk. Both camps, and at San Bernardino ranch, 1905.
4729 albiceralis Grt. San Bernardino ranch, 1905.
4731 labeculalis Hulst.
4741 ophionalis Wlk. Bill Williams fork, 1903, and Tucson.
4766 Titanio helianthialis Murtf. Tucson and Bill Williams fork, 1903, and San Bernardino ranch, 1905.
4780 Phlyctænia extricalis Gn. San Bernardino ranch, 1905.
4827 Pyrausta tyralis Gn.
4849 Noctuelia thalialis Wlk.
4871 Elophila fulicalis Clem. Bill Williams fork, 1903, and San Bernardino ranch, 1905.
schaefferalis Dyar. Oak Creek canyon, 1904.

Family PYRALIDÆ.

4906 Acallis griphalis Hulst.
4914 Schœnobius sordidellis Zinck. San Bernardino ranch, 1905.
4917 mellinellus Clem. Bill Williams Fork, 1903, and San Bernardino ranch, 1905.
4924 Prionapteryx achatina Zell.
baboquivariella Kearfott. New species.
4964 Crambus coloradellus Fern.
near haustuellus. San Bernardino ranch, 1905.
new species.
4984 Thaumatopsis magnifica Fern.
4991 Ommatopteryx ocellea Haw. San Bernardino ranch, 1905, and Tucson.
4994 Argyria argentana Martyn.
5008 Dicymolomia metalliferalis Pack. San Bernardino ranch, 1905.
5021 Cacozelia basiochrealis Grt.
5024 Jocara dentilineella Hulst.
5027 Yuma trabalis Grt.
5029 Benta asperatella Clem.
5030 melanogrammos Zell.
5046 Attacapa callipeplella Hulst. San Bernardino ranch, 1905.
5164 Elasmopalpus lignocellus Zell. Tucson.
5176 Epischnia boisduvaliella Gn.? San Bernardino ranch, 1905.
5182 Getulia flavidorsella Rag.
5201 Melitara fernaldalis Hulst.
5206 Zophodia glaucatella Hulst.
polingella Dyar.
5230 Heterographis morrisonella Rag. San Bernardino ranch, 1905.
5253 Homœosoma electellum Hulst. San Bernardino ranch, 1905.
5263 Ephestioides gilvescentella Rag.
5278 Plodia interpunctella Hbn. San Bernardino ranch, 1905.
5279 Ragonotia dotalis Hulst. San Bernardino ranch, 1905.
5295 Saluria dichroella Rag.

Family PTEROPHORIDÆ.

5347 Alucita belfragei Fish. Tucson.

Family TORTRICIDÆ.

5410 Bactra furfurana Haw.
5484 Eucosma bolanderana Wlsm.
5533 pulveratana Wlsm. Bill Williams fork, 1903, and San Bernardino ranch, 1905.
5537 constrictana Zell. San Bernardino ranch, 1905.
5539 solicitana Wlk. San Bernardino ranch, 1905.
5541 strenuana Wlk. San Bernardino ranch, 1905.
5542 perplexana Fern. San Bernardino ranch, 1905.
5553 scudderiana Clem. San Bernardino, 1905.
5582 Cydia perangustana Wlsm. San Bernardino ranch, 1905.
5599 rœssleri Zell. San Bernardino ranch, 1905.
5639 Epinotia crispana Clem. Also at San Bernardino ranch, 1905.
5792 Archips virescana Clem. San Bernardino ranch, 1905.

Family YPONOMEUTIDÆ.

6040 Plutella maculipennis Curt. San Bernardino ranch, 1905.
yumatella Kearfott. New species. San Bernardino ranch, 1905. Described in *Canadian Entomologist*, January, 1907.

Family GELECHIIDÆ.

6160 Phthorimæa operculella Zell. Also at San Bernardino ranch, 1905.
6228 Gelechia albilorella Zell.
6233 paulella Busck.
6240 striatella Busck.
6251 lindenella Busck. Also at San Bernardino ranch, 1905.
6345 Trichotaphe inversella Zell.
simpliciella Busck.
6366 Ypsolophus eupatoriellus Cham.

Family BLASTOBASIDÆ.

Holcocera arizoniella Kearfoot. New species. San Bernardino ranch, 1905. Described in *Canadian Entomologist*, January, 1907.

Family ŒCOPHORIDÆ.

6453 Ethmia marmorea Wlsm.

Family ELACHISTIDÆ.

6654 Scythris trivinctella Zell. Bill Williams fork, 1903, and San Bernardino ranch, 1905.

Family TINEIDÆ.

Amydrya confusella Dietz. San Bernardino ranch, 1905.
arizonella Dietz. San Bernardino ranch, 1905.
marjoriella Dietz. San Bernardino ranch, 1905.
crescentella Kearfott. New species. Described in *Canadian Entomologist*, January, 1907.
Setomorpha operosella Zell. San Bernardino ranch, 1905.
Eulepiste cockerellii Dyar. San Bernardino ranch, 1905.
7119 maculifer Wlsm.
7129 Acrolophus simulatus Wlsm.
7134 Anophora popeanella Clem. Bill Williams fork, 1903, and San Bernardino ranch, 1905.
7138 Ortholophus variabilis Wlsm. Also at Bill Williams fork, 1903, and San Bernadino ranch, 1905.
7139 Felderia filicicornis Wlsm.
7141 Pseudanophora davisellus Beut.

SUMMARIES OF FAMILIES AND SPECIES.

Nymphalidæ	8	Geometridæ	30
Libytheidæ	1	Limacodidæ	4
Erycinidæ	3	Megalopygidæ	1
Lycænidæ	7	Pyromorphidæ	2
Papilionidæ	7	Thyridæ	1
Hesperidæ	12	Pyralidæ	47
Sphingidæ	2	Pterophoridæ	1
Saturnidæ	1	Tortricidæ	12
Ceratocampidæ	1	Yponomeutidæ	2
Syntomidæ	2	Gelechiidæ	8
Arctiidæ	7	Blastobasidæ	1
Agaristidæ	2	Œcophoridæ	1
Noctuidæ	56	Elachistidæ	1
Notodontidæ	7	Tineidæ	12
Liparidæ	1		

Totals: Families, 29; species, 240.

III.—LIST OF HEMIPTERA-HETEROPTERA.

For the determination of species in this order the author is debted to Mr. E. P. Van Duzee.

Numbers according to Uhler's check-list.

Family SCUTELLERIDÆ.

27 Sphyrocoris punctellus Stal.

Family CORIMELÆNIDÆ.

53 Corimelæna nitiduloides Wolff.
58 extensa Uhl.
64 nigra Dallas.

Family CYDNIDÆ.

75 Cyrtomenus mirabilis Perty.
104 Pangæus spangbergi Sign.?

Family PENTATOMIDÆ.

140 Perillus confluens H.-Sch.
146 Mineus strigipes H.-Sch.?
186 Brochymena arborea Say.
192 obscura H.-Sch.
201 Discocephala clypeata Stal.
Hymenarcys crassa Uhl.
294 Trichopepla semivittata Say.
300 Thyanta custator Fab. Tucson.
303 rugulosa Say, var.

Family COREIDÆ.

440 Pachylis gigas Burm.
446 Mozena lineolata H.-Sch.
447 lunata Burm.

Family COREIDÆ.

482 Acanthocephala granulosus Dallas.
493 Leptoglossus zonatus Dallas.
501 Narnia pallidicornis Stal.
snowi Van D. New species. San Bernardino ranch, 1905.
Described in *Canadian Entomologist*, January, 1907.
527 Anasa armigera Say. Tucson.
507 Chelinidea vittigera Uhl. Also at Tucson.
560 Hyalymenus tarsatus Fab.
563 Alydus calcaratus Fab.
setosus Van D. New species.
587 Harmostes reflexulus Stal.
595 Corizus hyalinus Fab. Tucson.

Family BERYTIDÆ.

Jalysus wickhami Van D. New species.

Family LYGÆIDÆ.

658 Ligyrocoris sylvestris Linn.
715 Lygæus facetus Say.
743 bicolor H.-Sch.
752 reclivatus Say.
753 turcicus Fab.
759 Oncopeltus fasciatus Dallas.
Lygæosoma solida Uhl.

Family PYRRHOCORIDÆ.

766 Largus succinctus Linn.
773 Arhaphe carolina H.-Sch.
779 Dysdercus obliquus H.-Sch.

Family CAPSIDÆ.

847 Phytocoris eximius Reut.
860 Calocoris rapidus Say. Tucson.
863 superbus Uhl. Tucson.
864 fulvomaculatus De G. Tucson.
892 Lygus scutellatus Dist. Tucson.
902 Pœciloscytus basalis Reut. Tucson.

Family ARADIDÆ.

1106 Brachyrhynchus mœstus Stal.

Family PHYMATIDÆ.

1118 Phymata wolffii Stal.

Family NABIDÆ.

1144 Coriscus ferus Linn. Tucson.

Family REDUVIDÆ.

Sinea rileyi Montcl.
complexa Caud. At both camps.
1152 diadema Fab. Tucson.
1197 Diplodus exsanguis Stal. Tucson.
1209 Pindus socius Uhl.

Family REDUVIDÆ.

1212 Apiomerus subpiceus Stal.?, possibly immundus Bergr.
1214 crassipes Fab.
1218 ventralis Say.
spissipes Say.
longispinus Champ.
Homalocoris minutus Mayr.
1232 Rasahus thoracicus Stal.
1248 Conorhinus variegatus Drury.
maximus Uhl.
Reduvius senilis Van D. New species.

Family HYDROBATIDÆ.

1302 Hygrotrechus remigis Say.

Family GALGUDIDÆ.

1357 Gelastocoris oculatus Fab.
undetermined species.

Family BELOSTOMATIDÆ.

Pedinocoris sp. Tucson.

Family NOTONECTIDÆ.

1401 Notonecta mexicana Am. et S.

Family CORIXIDÆ.

Corixa, two species.

SUMMARY OF FAMILIES AND SPECIES OF HEMIPTERA-HETEROPTERA.

Scutelleridæ	1	Aradidæ	1
Corimelænidæ	3	Phymatidæ	1
Cydnidæ	2	Nabidæ	1
Pentatomidæ	9	Reduviidæ	15
Coreidæ	14	Hydrobatidæ	1
Berytidæ	1	Galgulidæ	2
Lygæidæ	7	Belostomatidæ	1
Pyrrhocoridæ	3	Notonectidæ	1
Capsidæ	6	Corixidæ	2

Totals: Families, 18; species, 71.

IV.—LIST OF ORTHOPTERA.

The author hereby expresses his grateful acknowledgments to Mr. J. A. G. Rehn, of the Philadelphia Academy of Natural Sciences, for the determination of a large portion of the material in this order of insects. This list includes all the Arizona species collected by the expeditions of 1902, 1903, 1904, 1905, and 1906.

Family FORFICULIDÆ.

Apterygida linearis Esch. San Bernardino ranch.

Family BLATTIDÆ.

Pseudomops oblongata Linn. San Bernardino ranch.
Stylopyga orientalis Linn. San Bernardino ranch.
Homœogamia bolliana Sauss. Oak creek canyon, Baboquivari mountains.
erratica Rehn. New species. San Bernardino ranch, Baboquivari mountains.

Family MANTIDÆ.

Litaneutria minor Scudd. San Bernardino ranch, Baboquivari mountains, Bill Williams fork, Cactus plain.
Vates paracusis Sauss. Baboquivari mountains.
Stagmomantis limbata Hahn. Bill Williams fork, San Bernardino ranch.
gracilipes Rehn. New species. Baboquivari mountains.

Family PHASMIDÆ.

Diapheromera arizonensis Caud San Bernardino ranch.
Pseudosermyle truncata Caud. San Bernardino ranch.

Family ACRIDIIDÆ.

Tettix granulatus Kirb. Oak Creek canyon.
Clypeotettix schochii Bol. Baboquivari mountains.
Paratettix toltecus Sauss. Oak Creek canyon, Bill Williams fork, San Bernardino ranch, Tucson.
toltecus Sauss, race arizonus Hanc. San Bernardino ranch, Bill Williams fork, Tucson.
toltecus Sauss, form sonorensis Hanc. Oak Creek canyon, Bill Williams fork, Tucson.
Telmatettix aztecus Sauss. Bill Williams fork, Baboquivari mountains, Tucson.
Achurum acridodes Stal. Baboquivari mountains.
Mermiria bivittata Serv. San Bernardino ranch.
neomexicana Thom. Baboquivari mountains.
texana Brun. Oak Creek canyon.
admirabilis Uhl. San Bernardino ranch, Baboquivari mountains.
Syrbula fuscovittata Thom. San Bernardino ranch, Baboquivari mountains.
Acrocara maculipennis Scudd. San Bernardino ranch.
Eritettix variabilis Brun. San Bernardino ranch.
Bootettix argentatus Brun. Bill Williams fork.
Amphitornus ornatus McNeill. Oak Creek canyon, Baboquivari mountains.
Opeia testacea Scudd. San Bernardino ranch.

Family ACRIDIIDÆ.

Cordillacris pima Rehn. New species. Baboquivari mountains.
Orphulella compta Scudd. Bill Williams fork, San Bernardino ranch.
Gomphocerus clepsydra Scudd. Oak Creek canyon.
Boopedon fuscum Brun. San Bernardino ranch.
Psoloessa buddiana Brun. Baboquivari mountains.
maculipennis Scudd. Baboquivari mountains, San Bernardino ranch.
texana Scudd. Baboquivari mountains.
Stirapleura pusilla Scudd. Baboquivari mountains.
Ageneotettix australis Brun. Baboquivari mountains.
Aulocara elliotti Thom. San Bernardino ranch.
rufum Scudd. San Bernardino ranch, Baboquivari mountains.
Ligurotettix kunzei Caud. Bill Williams fork, Cactus plain.
Arphia aberrans Brun. Baboquivari mountains.
arcta Scudd. Oak Creek canyon.
crassa Brun. San Bernardino ranch.
Encoptolophus texensis Brun. San Bernardino ranch, Tucson.
Camnula pellucida Scudd. Oak Creek canyon, Humphrey's Peak, at base.
Hippiscus conspicuus Scudd. Baboquivari mountains.
corallipes Hald. Baboquivari mountains, San Bernardino ranch.
Scyllina calida Brun. San Bernardino ranch, Baboquivari mountains.
Leprus cyaneus Ckll. Baboquivari mountains.
Dissosteira carolina Linn. Oak Creek canyon.
Spharagemon collare Scudd., var. angustipenne Morse. San Bernardino ranch.
Lactista oslari Caud. Tucson.
Tomonotus aztecus Sauss. Baboquivari mountains, San Bernardino ranch.
ferrugineus Brun. Baboquivari mountains.
Derotmema delicatum Scudd. Bill Williams fork, San Bernardino ranch, Baboquivari mountains.
haydeni Thom. Flagstaff, San Bernardino ranch, Bill Williams fork.
Trepidulus rosaceus McNeill. Bill Williams fork.
melleolus Scudd. San Bernardino ranch.
Mestobregma plattei Thom. Baboquivari mountains.
rubripennis Brun. Baboquivari mountains.
Conozoa carinata Rehn. New species. Tucson, Baboquivari mountains.
sulcifrons Scudd. Bill Williams fork, Baboquivari mountains, Tucson.
Trimerotropis bruneri McNeill. Baboquivari mountains.
cyanipennis Brun. Oak Creek canyon.
fascicula McNeill. Oak Creek canyon, Humphrey's Peak, at base, Baboquivari mountains.
laticincta Sauss. San Bernardino ranch, Flagstaff.
modesta Brun. Oak Creek canyon.
snowi Rehn. New species. (Trans. Kan. Acad. Sci., vol. XIX, p. 223.) Congress Junction.
strenua McNeill. San Bernardino ranch.
vinculata Scudd. Oak Creek canyon, San Bernardino ranch, Tucson, Baboquivari mountains.
Circotettix undulatus Thom. Oak Creek canyon, Humphrey's Peak, at base.

Family ACRIDIIDÆ.

Anconia integra Scudd. Bill Williams fork.
Heliastes aridus Brun. Bill Williams fork, San Bernardino ranch, Congress Junction, Baboquivari mountains.
benjamini Caud. Baboquivari mountains.
minimus Scudd. Bill Williams fork.
Tytthotyle maculata Brun. Bill Williams fork.
Brachystola intermedia Brun. San Bernardino ranch.
Phrynotettix magnus Thom. San Bernardino ranch, Baboquivari mountains.
Paropomala cylindrica Brun. San Bernardino ranch.
Leptysma marginicollis Serv. Bill Williams fork.
Schistocerca shoshone Thom. Bill Williams fork, San Bernardino ranch.
vaga Scudd. Bill Williams fork, San Bernardino ranch, Tucson, Baboquivari mountains.
venusta Scudd. Oak Creek canyon.
Conalcœa huachucana Rehn. Baboquivari mountains.
Hesperotettix festivus Scudd. Tucson, Baboquivari mountains.
Æoloplus tenuipennis Scudd. Bill Williams fork.
Melanoplus aridus Scudd. San Bernardino ranch.
atlantis Riley. San Bernardino ranch, Baboquivari mountains.
brownii Caud. Baboquivari mountains.
canonicus Scudd. Bill Williams fork, Tucson.
differentialis Uhl. San Bernardino ranch.
femur-rubrum De G. San Bernardino ranch.
flavescens Scudd. Bill Williams fork.
flavidus Scudd. Oak Creek canyon, Bill Williams fork, San Bernardino ranch.
olivaceus Scudd. Oak Creek canyon.
spretus Uhl. Tucson, Baboquivari mountains.
thomasi Scudd. San Bernardino ranch.
yarrowi Thom. Bill Williams fork.
Phœtaliotes nebrascensis Thom. San Bernardino ranch.
Pœcilotettix sanguineus Scudd. Bill Williams fork.
Dactylotum pictum Thom. Baboquivari mountains.

Family LOCUSTIDÆ.

Hormilia elegans Scudd. San Bernardino ranch.
Arethæa constricta Brun. Baboquivari mountains, Tucson.
Scudderia furcifera Scudd. Oak Creek canyon.
mexicana Sauss. Tucson, Baboquivari mountains.
Amblycorypha huasteca Sauss. Oak Creek canyon.
Microcentrum laurifolium Linn. Oak Creek canyon.
Conocephalus mexicanus Sauss. Bill Williams fork.
Xiphidium fasciatum De G. San Bernardino ranch.
Capnobotes fuliginosus Thom. Congress Junction, San Bernardino ranch, Baboquivari mountains.
Eremopedes ballii Caud. Oak Creek canyon, Baboquivari mountains.
unicolor Scudd. San Bernardino ranch, Baboquivari mountains.
Plagiostira gracilis Rehn. New species. (Trans. Kan. Acad. Sci., vol. XIX, p. 227.) Bill Williams fork.

Family LOCUSTIDÆ.

Ateloplus notatus Scudd. Bill Williams fork, Baboquivari mountains, Tucson.

Stenopelmatus oculatus Scudd. Oak Creek canyon, Humphrey's Peak, at base.

Ceuthophilus paucispinosa Rehn. New species. (Trans. Kan. Acad. Sci., vol. XIX, p. 227.) Oak Creek canyon.

Phrixocnemis franciscanus Rehn. New species. (Trans. Kan. Acad. Sci., vol. XIX, p. 228.) Humphrey's Peak, at base.

socorrensis Rehn. New species. (Trans. Kan. Acad. Sci., vol. XIX, p. 229.) Humphrey's Peak, at base.

Udeopsylla serrata Rehn. New species. (Trans. Kan. Acad. Sci., vol. XIX, p. 230.) Oak Creek canyon.

Family GRYLLIDÆ.

Ellipes minuta Scudd. San Bernardino ranch.

Tridactylus apicalis Say. Bill Williams fork.

Nemobius neomexicanus Scudd. San Bernardino ranch.

Gryllus armatus Scudd. San Bernardino ranch, Baboquivari mountains, Tucson.

pennsylvanicus Burm. Bill Williams fork.

personatus Uhl. San Bernardino ranch.

Miogryllus lineatus Scudd. Baboquivari mountains.

Œcanthus californicus Sauss.? Tucson, Baboquivari mountains.

quadripunctatus Reut. Bill Williams fork, Oak Creek canyon, San Bernardino ranch.

SUMMARY OF FAMILIES AND SPECIES OF ORTHOPTERA.

Forficulidæ	1	Acridiidæ	90
Blattidæ	4	Locustidæ	18
Mantidæ	4	Gryllidæ	9
Phasmidæ	2		

Totals: Families, 7; species 128.

LIST OF COLEOPTERA COLLECTED IN NEW MEXICO BY THE ENTOMOLOGICAL EXPEDITIONS OF THE UNIVERSITY OF KANSAS.

By F. H. Snow, University of Kansas, Lawrence.

THE writer has conducted six expeditions to New Mexico for the purpose of collecting insects for the museum of the University of Kansas. These were all in the months of July and August, in the years 1880, 1881, 1882, 1883, 1884, and 1894. The first expedition had its headquarters eight miles north of the city of Santa Fé, in the Santa Fé canyon, at an altitude of 7000 feet above sea-level; the second expedition had its camp in Water canyon, twenty-five miles west of Socorro, where our work was prematurely closed by an invasion of Apache Indians; the third and fourth camps were located at the Gallinas canyon, less than a mile above the Las Vegas hot springs, at an altitude of 7000 feet; the fifth was along Walnut creek, a tributary of the Gila river, about twelve miles north of Silver City and three miles west of the "continental divide"; the sixth expedition had its headquarters in Hop canyon, in the Magdalena mountains, about thirty miles west of Socorro. The results of the last expedition have never been published, and it has been thought desirable to gather into a single list the combined results of the six expeditions to New Mexico.

The numbers are those of Henshaw's list.

Family Cicindelidæ.

16 Cicindela obsoleta Say. Gallinas canyon.
16*a* vulturina Lec. Gallinas canyon.
16*b* prasina Lec. Gallinas canyon.
18 longilabris Say. Santa Fe canyon.
19*a* unicolor Dej. Socorro.
20 nigrocærulea Lec. Gallinas canyon.
21 pulchra Say. Gallinas canyon. Socorro.
25*a* audubonii Lec. Gallinas canyon.
25*c* cimarrona Lec. Gallinas canyon, Socorro, Santa Fe canyon.
28 fulgida Say. Albuquerque.
32 vulgaris Say. Albuquerque, Gallinas canyon, Santa Fe canyon.
32*a* obliquata Kirby. Gallinas canyon.
33*a* oregona Lec. Gallinas canyon.
33*b* guttifera Lec. Santa Fe canyon.
35 hirticollis Say. Socorro.
36 cinctipennis Lec. Gallinas canyon.
36*a* imperfecta Lec. Gallinas canyon.

Family CICINDELIDÆ.

40 Cicindela punctulata Fab. Gallinas canyon, Santa Fe canyon, Socorro.
40*a* micans Fab. Gallinas canyon, Santa Fe canyon.
47 macra Lec. Socorro.
51 sperata Lec. Socorro, Albuquerque.
57 lemniscata Lec. Deming.
58*a* prætextata Lec. Socorro.
64*b* 16-punctata Kl. Gallinas canyon.

Family CARABIDÆ.

76 Omophron americanum Dej. Santa Fe canyon, Walnut creek.
86 Cychrus elevatus Fab. Santa Fe canyon, Gallinas canyon.
88 snowii Lec. Santa Fe canyon.
119 Carabus tædatus Fab. Santa Fe canyon, Gallinas canyon.
121 serratus Say. Santa Fe canyon.
127 Calosoma scrutator Fab. Gallinas canyon.
132 prominens Lec. Albuquerque.
133 peregrinator Guer. Albuquerque, Gallinas canyon, Water canyon.
133 form carbonatum Lec. Albuquerque.
136 triste Lec. Albuquerque, Water canyon.
137 obsoletum Say. Magdalena mountains, Gallinas canyon.
179 Notiophilus hardyi Putz. Gallinas canyon.
192 Nebria obliqua Lec. Santa Fe canyon, Walnut creek.
194 hudsonica Lec. Walnut creek.
195 sahlbergi Fisch. Gallinas canyon.
195 sahlbergi Fisch., var. Gallinas canyon.
215*a* Pasimachus costifer Lec. Gallinas canyon, Water canyon.
217 elongatus Lec. Gallinas canyon, Santa Fe canyon.
219 californicus Chd. Walnut creek.
232 Dyschirius globulosus Say. Santa Fe canyon.
287 Schizogenius depressus Lec. Walnut creek.
322 Bembidium longulum Lec. Santa Fe canyon.
343 transversale Dej. Santa Fe canyon, Gallinas canyon.
345 lugubre Lec. Santa Fe canyon, Gallinas canyon, Magdalena mountains.
347 striola Lec. Santa Fe canyon, Gallinas canyon, Magdalena mountains.
347 striola Lec., var. Walnut creek.
349 bimaculatum Kirby. Santa Fe canyon.
351 lucidum Lec. Santa Fe canyon, Gallinas canyon, Magdalena mountains.
358 picipes Kirby. Santa Fe canyon.
363 grapii Gyll. Gallinas canyon.
388 intermedium Kirby. Gallinas canyon, Santa Fe canyon.
412 connivens Lec. Santa Fe canyon.
414 assimile Gyll. Santa Fe canyon.
417 quadrimaculatum Linn. Santa Fe canyon.
new species, near incertum Mots. (*fide* Roland Hayward, May, 1904). Walnut creek.

Family CARABIDÆ

Bembidium new species, allied to grapei Gyll. (*fide* Roland Hayward, May, 1904). Gallinas canyon.
449 Tachys nanus Gyll. Gallinas canyon, Santa Fe canyon.
near tripuncatatus Say. Walnut creek.
461 incurvus Say. Santa Fe canon.
483 Trechus chalybeus Mann. Santa Fe canyon, Walnut creek.
504 Pterostichus protractus Lec. Santa Fe canyon.
506 longulus Lec. Santa Fe canyon, Gallinas canyon.
524 substriatus Lec. Water canyon, Gallinas canyon.
525 constrictus Say. Walnut creek.
583 luczotii Dej. Santa Fe canyon, Gallinas canyon.
618 Evarthrus torvus Lec. Gallinas canyon.
647 Amara latior Kirby. Santa Fe canyon.
664 fallax Lec. Walnut creek.
666 confusa Lec. Santa Fe canyon, Water canyon, Gallinas canyon, Magdalena mountains.
668 polita Lec. Santa Fe canyon.
669 erratica Sturm. Santa Fe canyon, Gallinas canyon.
670 interstitialis Dej. Gallinas canyon.
670 interstitialis Dej., var. Gallinas canyon.
676 terrestris Lec. Santa Fe canyon.
678 remotestriata Dej. Santa Fe canyon.
680 gibba Lec. Santa Fe canyon.
684 harpalina Lec. Water canon.
743 Calathus ingratus Dej. Santa Fe canyon.
749 advena Lec. Walnut creek.
751 dubius Lec. Magdalena mountains, Santa Fe canyon, Gallinas canyon.
758 Platynus nivalis Horn. Magdalena mountains, Santa Fe canyon, Water canyon.
766 sinuatus Dej., var. Santa Fe canyon.
771 brunneomarginatus Mann. Walnut creek.
771 brunneomarginatus Mann., var. Walnut creek.
772 extensicollis Say. Gallinas canyon.
800 cupripennis Say. Santa Fe canyon.
815 placidus Say. Santa Fe canyon, Gallinas canyon, Magdalena mountains.
822 quadripunctatus De G. Gallinas canyon.
823 bembidioides Kirby. Gallinas canyon.
842 Lachnophorus elegantulus Mann. Gallinas canyon.
843 Euphorticus pubescens Dej. Walnut creek.
872 Lebia grandis Hentz. Walnut creek.
875 majuscula Chd. Gallinas canyon.
882 viridis Say. Gallinas canyon.
891 scapula Horn. Walnut creek.
892 analis Dej., var. Walnut creek, Socorro.
893 fuscata Dej. Gallinas canyon.
895 scapularis Dej. Gallinas canyon.
902 bivittata Fab. Gallinas canyon.
914 Metabletus americanus Dej. Santa Fe canyon.

Family CARABIDÆ

919 Callida platynoides Horn. Walnut creek.
926 Philophuga viridicollis Lec. Gallinas canyon.
936 Pinacodera punctigera Lec. Walnut creek.
939 Cymindis laticollis Say. Santa Fe canyon, Gallinas canyon.
940 cribricollis Dej. Santa Fe canyon, Gallinas canyon.
Brachynus cinctipennis Chev. Albuquerque.
978 cordicollis Dej. Albuquerque.
985 tschernikhii Mann. Walnut creek.
new species. Walnut creek.
991 Chlænius ruficauda Chd. Walnut creek.
1010 obsoletus Lec. Walnut creek.
1021 pennsylvanicus Say. Albuquerque.
1054 Nothopus zabroides Lec. Albuquerque, Gallinas canyon.
1057 Piosoma setosum Lec. Magdalena mountains, Water canyon.
1059 Agonoderus lineola Fab. Albuquerque.
1068 Discoderus impotens Lec. Albuquerque.
1078 Harpalus autumnalis Say. Magdalena mountains, Socorro.
1080 retractus Lec. Santa Fe canyon, Albuquerque, Gallinas canyon.
1081 amputatus Say. Gallinas canyon.
1083 caliginosus Fab. Gallinas canyon, Albuquerque, Santa Fe canyon, Water canyon.
1087*a* compar Lec. Santa Fe canyon.
1089 spadiceus Dej. Gallinas canyon.
1091 fallax Lec. Gallinas canyon.
1094 herbivagus Say. Santa Fe canyon, Gallinas canyon.
1097 opacipennis Hald. Magdalena mountains, Gallinas canyon.
1099 ellipsis Lec. Water canyon, Santa Fe canyon.
1103 carbonatus Lec. Magdalena mountains.
1105 montanus Lec. Santa Fe canyon, Gallinas canyon.
1110 funestus Lec. Santa Fe canyon, Gallinas canyon, Water canyon, Magdalena mountains.
1111 oblitus Lec. Water canyon.
1112 clandestinus Lec. Socorro, Magdalena mountains.
1115 ochropus Kirby. Santa Fe canyon, Water canyon, Gallinas canyon.
1116 lustrans Casey. Water canyon.
1117 basilaris Kirby. Water canyon.
1122 cordatus Lec. Magdalena mountains.
1123 obliquus Horn. Magdalena mountains, Socorro.
undetermined species. Water canyon.
1125 Selenophorus pedicularius Dej. Santa Fe canyon, Gallinas canyon.
1140 Stenolophus conjunctus Say. Santa Fe canyon.
1142 cincticollis Lec. Gallinas canyon.
1145 ochropezus Say. Albuquerque.
1164 Tachycellus nigrinus Dej. Santa Fe canyon.
1199 Anisodactylus maculicornis Chd. Walnut creek.
1205 lætus Dej. Albuquerque.

Family AMPHIZOIDÆ.

1216 Amphizoa lecontei Matth. Santa Fe canyon.

Family HALIPLIDÆ.

1228 Cnemidotus callosus Lec. Gallinas canyon.

Family DYTISCIDÆ.

1243 Laccophilus decipiens Lec. Santa Fe canyon, Gallinas canyon.
1244 proximus Say. Santa Fe canyon.
1297 Cœlambus nubilus Lec. Santa Fe canyon, Gallinas canyon.
1306 Deronectes striatellus Lec. Santa Fe canyon, Gallinas canyon, Socorro, Water canyon.
1340 Hydroporus rivalis Gyll. Santa Fe canyon.
1370 vilis Lec. Santa Fe canyon, Gallinas canyon.
1389 Ilybius biguttalus Germ. Santa Fe canyon, Gallinas canyon, Water canyon.
1391 laramæus Lec. Santa Fe canyon, Gallinas canyon.
1400 Ilybiosoma regularis Lec. Gallinas canyon.
1406 Agabus cordatus Lec. Santa Fe canyon, Gallinas canyon.
1408 intersectus Cr. Santa Fe canyon.
1413 lugens Lec. Santa Fe canyon.
1423 semipunctatus Kirby. Santa Fe canyon.
1435 austinii Sharp. Santa Fe canyon.
1449 tristis Aube. Santa Fe canyon.
1459 Rhantus binotatus Harr. Santa Fe canyon, Gallinas canyon, Magdalena mountains.
1461 atricolor Aube. Walnut creek.
1495 Thermonectes ornaticollis Aube. Albuquerque.
1495*a* nigrofasciatus Aube. Albuquerque.
1496 basilaris Harr. Albuquerque.
1503 Cybister ellipticus Lec. Albuquerque.

Family HYDROPHILIDÆ.

1586 Hydrophilus triangularis Say. Gallinas canyon, Albuquerque.
1589 nimbatus Say. Gallinas canyon, Santa Fe canyon.
1591 glaber Hbst. Santa Fe canyon.
1592 californicus Lec. Water canyon, Santa Fe canyon.
1594 ellipticus Lec. Water canyon, Santa Fe canyon.
1613 Berosus infuscatus Lec. Gallinas canyon.
1620 Limnebius piceus Horn. Gallinas canyon.
1622 Laccobius ellipticus Lec. Santa Fe canyon.
1626 Philhydrus nebulosus Say. Santa Fe canyon.
1634 diffusus Lec. Gallinas canyon, Albuquerque, Santa Fe canyon.
1642 Hydrocombus fimbriatus Melsh. Santa Fe canyon.
1646 Hydrobius scabrosus Horn. Santa Fe canyon.
1653 fuscipes Linn. Santa Fe canyon.
1654 rufiventris Horn. Santa Fe canyon, Gallinas canyon.
1655 infuscatus Mots. Santa Fe canyon, Gallinas canyon.
1657 subcupreus Say. Santa Fe canyon.

Family SILPHIDÆ.

1698 Necrophorus marginatus Fab. Santa Fe canyon, Gallinas canyon, Water canyon.
1700 guttula Mots. Santa Fe canyon, Gallinas canyon.
1705 Silpha truncata Say. Santa Fe canyon, Gallinas canyon, Magdalena mountains.
1706 lapponica Hbst. Santa Fe canyon, Gallinas canyon, Water canyon.
1729 Choleva basillaris Say. Walnut creek.
1770 Anisotoma valida Horn. Gallinas canyon.
1782 Liodes globosa Lec. Walnut creek.

Family STAPHYLINIDÆ.

1996 Falagria cingulata Lec. Socorro.
Ætheta, three undetermined species. Gallinas canyon.
Homalota, undetermined species. Gallinas canyon.
2044 Tachyusa nigrella Lec. Santa Fe canyon.
2055 Aleochara bimaculata Grav. Santa Fe canyon, Gallinas canyon, Magdalena mountains.
2059 nitida Grav. Gallinas canyon.
Thiasophila, undetermined species. Gallinas canyon.
Gyrophæna, undetermined species. Walnut creek.
2096 Heterothops fumigatus Lec. Santa Fe canyon.
2096*b* californicus Lec. Gallinas canyon.
2098 Quedius explanatus Lec. Gallinas canyon, Santa Fe canyon, Magdalena mountains.
2099 spelæus Horn. Gallinas canyon.
2100 fulgidus Fab. Magdalena mountains.
2106 lævigatus Gyll. Magdalena mountains.
2107 molochinus Grav. Gallinas canyon.
2108 hyperboreus Er. Gallinas canyon.
2119 Creophilus villosus Grav. Gallinas canyon, Santa Fe canyon.
2132 Staphylinus mysticus Er. Walnut creek.
2136 fossator Grav. Gallinas canyon, Santa Fe canyon.
2137 comes Lec. Walnut creek.
2138 cinnamopterus Grav. Gallinas canyon.
2146 Belonuchus formosus Grav. Walnut creek.
2150 Philonthus furvus Nord. Santa Fe canyon, Gallinas canyon.
2170 flavolimbatus Er. Santa Fe canyon. Walnut creek.
2177 debilis Grav. Santa Fe canyon.
2178 varians Payk. Gallinas canyon.
2179 longicornis Steph. Santa Fe canyon.
2191 triangulum Horn. Santa Fe canyon.
2204 sordidus Grav. Water canyon.
2221 nigritulus Grav. Gallinas canyon.
2226 picicornis Horn. Gallinas canyon.
2230 quadrulus Horn. Walnut creek.
undetermined species. Walnut creek, Water canyon.
2301 Dianous nitidulus Lec. Santa Fe canyon.
Stenus, undetermined species. Gallinas canyon.

Family STAPHYLINIDÆ.

Lithocharis, new species. Walnut creek.
Conosoma, undetermined species. Walnut creek.
2670 Bryoporus rufescens Lec. Walnut creek.
2737 Bledius ornatus Lec. Santa Fe canyon, Albuquerque.
2747 Platystethus americanus Er. Santa Fe canyon, Gallinas canyon.
2753 Oxytelus fuscipennis Mann. Santa Fe canyon.
Trogophlœus, undetermined species. Socorro.
2801 Geodromicus ovipennis Lec. Santa Fe canyon, Gallinas canyon.
Deliphrum brevicolle.
Homalium, undetermined species. Magdalena mountains.
2911 Micropeplus tesserula Curt. Gallinas canyon.

Family TRICHOPTERYGIDÆ.

Trichopteryx, undetermined species. Gallinas canyon.

Family PHALACRIDÆ.

2992 Phalacrus penicillatus Say. Gallinas canyon.
2996 Olibrus vittatus Lec. Gallinas canyon, Walnut creek.
3007 nitidus Melsh. Walnut creek.
two undetermined species. Gallinas canyon.

Family COCCINELLIDÆ.

3037 Megilla vittigera Mann. Albuquerque.
3041 Hippodamia 5-signata Kirby. Water canyon.
3043 lecontei Muls. Gallinas canyon, Albuquerque.
3046 convergens Guer. Gallinas canyon, Santa Fe canyon, Water canyon, Magadalena mountains.
3048 oregonensis Cr. Walnut creek.
3049 sinuata Muls. Walnut creek.
3051 parenthesis Say. Gallinas canyon.
3058 Coccinella 9-notata Hbst. Gallinas canyon.
3059 transversoguttata Fab. Gallinas canyon, Santa Fe canyon.
3060 monticola Muls. Gallinas canyon.
3064 sanguinea Linn. Gallinas canyon, Santa Fe canyon.
3065*a* Olla abdominalis Say. Gallinas canyon, Water canyon.
3069 Harmonia picta Rand. Gallinas canyon.
Anatis lecontei Casey. Gallinas canyon, Magdalena mountains.
3077 subvittata Muls. Gallinas canyon, Santa Fe canyon.
3078 Psyllobora 20-maculata Say. Gallinas canyon.
3078*a* tædata Lec. Magdalena mountains.
3082 Exochomus pilatii Muls. Gallinas canyon.
3083*a* æthiops Bland. Gallinas canyon.
3094 Brachyacantha dentipes Fab. Magdalena mountains.
3095*a* 10-pustulata Melsh. Gallinas canyon.
3101 Hyperaspis fimbriolata Melsh. Gallinas canyon.
3148 Scymnus collaris Melsh. Gallinas canyon.
3155 marginicollis Mann. Socorro.
3173 Epilachna corrupta Muls. Gallinas canyon, Water canyon, Albuquerque.

Family ENDOMYCHIDÆ.

3183 Aphorista morosa Lec. Santa Fe canyon, Magdalena mountains.
Mycetina morosa Lec. Gallinas canyon.
3197 Epipocus unicolor Horn. Gallinas canyon.

Family EROTYLIDÆ.

3209 Languria gracilis Newm. Water canyon.
3240 Erotylus boisduvali Chev. Water canyon, Santa Fe canyon, Gallinas canyon, Magdalena mountains.

Family COLYDIIDÆ.

3288 Bothrideres montanus Horn. Santa Fe canyon, Magdalena mountains.

Family CUCUJIDÆ.

3314 Pediacus fuscus Er. Gallinas canyon.

Family CRYPTOPHAGIDÆ.

3363 Henoticus serratus Gyll. Gallinas canyon.
Atomaria, two undetermined species. Gallinas canyon.
Salebius, undetermined species. Gallinas canyon.

Family MYCETOPHAGIDÆ.

3397 Mycetophagus pluripunctatus Lec. Gallinas canyon.

Family DERMESTIDÆ.

3418 Dermestes marmoratus Say. Water canyon, Santa Fe canyon, Gallinas canyon, Albuquerque.
3420 caninus Germ. Water canyon.
3421 talpinus Mann. Gallinas canyon.
3428 vulpinus Fab. Water canyon, Santa Fe canyon.
3445 Anthrenus varius Fab. Gallinas canyon.
3448 Cryptorhopalum balteatum Lec. Gallinas canyon.
2450 apicale Mann. Gallinas canyon.
3455 Orphilus glabratus Fab. Gallinas canyon, Santa Fe canyon.

Family HISTERIDÆ.

3471 Hister instratus Lec. Gallinas canyon.
3472 biplagiatus Lec. Magdalena mountains.
3483 marginicollis Lec. Santa Fe canyon.
3490 abbreviatus Fab. Santa Fe canyon, Magdalena mountains, Socorro, Gallinas canyon.
3491 civilis Lec. Magdalena mountains.
3494 depurator Say. Gallinas canyon, Santa Fe canyon.
3539 Epierus nasutus Horn. Gallinas canyon.
3583 Saprinus lugens Er. Gallinas canyon.
3585 pennsylvanicus Payk. Water canyon.
3586 oregonensis Lec. Gallinas canyon, Santa Fe canyon, Socorro.
3605 neglectus Mars. Gallinas canyon, Water canyon.
3610 fimbriatus Lec. Gallinas canyon, Santa Fe canyon.
3641 Teretrius montanus Horn. Santa Fe canyon.

Family NITIDULIDÆ.

3673 Carpophilus pallipennis Say. Gallinas canyon, Santa Fe canyon.
3674 dimidiatus Fab. Gallinas canyon.
3697 Epuræa rufa Say. Gallinas canyon.
3699 ambigua Mann. Socorro.
3704 immunda Sturm. Gallinas canyon.
3709 truncatella Mann. Walnut creek.
3713 æstiva Linn. Gallinas canyon.
3721 Nitidula ziczac Say. Gallinas canyon, Santa Fe canyon, Magdalena mountains.
3721 ziczac, var. Gallinas canyon.
3730 Soronia undulata Say. Gallinas canyon.
3733 Perthalycra murrayi Horn. Gallinas canyon, Santa Fe canyon.
3736 Orthopeplus quadricollis Horn. Walnut creek.
3739 Meligethes mutatus Harr. Santa Fe canyon, Gallinas canyon.
3751 Cybocephalus californicus Horn. Walnut creek.
3761 Pityophagus cephalotes Lec. Water canyon.
3762 rufipennis Horn. Walnut creek.
3763 verticalis Horn. Gallinas canyon, Walnut creek.
3767 Rhizophagus dimidiatus Mann. Walnut creek.

Family LATRIDIIDÆ.

3796 Coninomus carinatus Gyll. Gallinas canyon.
3799 Corticaria dentigera Lec. Gallinas canyon.
3804 delecta Mann. Gallinas canyon.
two undetermined species. Gallinas canyon.

Family TROGOSITIDÆ.

3832 Alindria teres Melsh. Magdalena mountains.
3833 Trogosita virescens Fab. Magdalena mountains.
3838 Tenebrioides corticalis Melsh. Magdalena mountains, Santa Fe canyon, Gallinas canyon.
3843 castanea Melsh. Santa Fe canyon.
3848 Peltis pippingskœldi Mann. Santa Fe canyon.
3850 Calitys scabra Thunb. Magdalena mountains.

Family BYRRHIDÆ.

3890 Byrrhus cyclophorus Kirby. Walnut creek.
new species. Walnut creek.
3903 Limnichus analis Lec. Santa Fe canyon.

Family PARNIDÆ.

3923 Dryops striatus Lec. Santa Fe canyon, Magdalena mountains, Gallinas canyon.
3924 suturalis Lec. Gallinas canyon.
3926 Elmis concolor Lec. Santa Fe canyon.
3933 divergens Lec. Santa Fe canyon.

Family DASCYLLIDÆ.

3986 Ptilodactyla serricollis Say. Gallinas canyon.

Family RHIPICERIDÆ.

4024 Sandalus californicus Lec. Walnut creek.

Family ELATERIDÆ.

4030 Deltometopus amœnicornis Say. Gallinas canyon.
4064 Anelastes drurii Kirby. Gallinas canyon, Santa Fe canyon, Magdalena mountains.
4077 Adelocera rorulenta Lec. Gallinas canyon.
Chalcolepidius apacheanus Casey. Walnut creek.
4095 Alaus melanops Lec. Gallinas canyon.
4109 Cardiophorus gagates Er. Magdalena mountains.
4110 longior Lec. Santa Fe canyon.
4113 tenebrosus Lec. Magdalena mountains.
4150 Cryptohypnus bicolor Esch. Santa Fe canyon.
4161 pectoralis Say. Santa Fe canyon.
4188 Monocrepidius sordidus Lec. Albuquerque.
4197 Ischiodontus soleatus Say. Albuquerque.
4202 Elater rhodopus Lec. Magdalena mountains.
4204 rubriventris Lec. Gallinas canyon.
4218 nigrinus Payk. Walnut creek.
4220 pullus Germ. Walnut creek.
new species. Gallinas canyon.
4299 Glyphonyx recticollis Say. Water canyon.
4322 Melanotus fissilis Say. Gallinas canyon.
4324 exuberans Lec. Gallinas canyon.
4344 paradoxus Melsh. Walnut creek.
4400 Athous cribratus Lec. Santa Fe canyon, Gallinas canyon.
4465 Corymbites rupestris Germ. Santa Fe canyon, Magdalena mountains.
4486 æripennis Kirby. Walnut creek.
4496 inflatus Say. Gallinas canyon.
4502 Asaphes carbonatus Lec. Gallinas canyon, Albuquerque.
4510 memnonius Hbst. Gallinas canyon.

Family BUPRESTIDÆ.

4567 Halecia gentilis Horn. Walnut creek.
4568 Chalcophora angulicollis Lec. Gallinas canyon.
4575*a* Psiloptera webbii Lec. Water canyon.
4576 Dicerca prolongata Lec. Gallinas canyon.
sexualis Cr. Gallinas canyon.
4594 Pœcilonota cyanipes Say. Gallinas canyon.
4602 Buprestis consularis Gory. Gallinas canyon.
4604 nuttalli Kirby. Gallinas canyon, Water canyon.
4606 maculiventris Say. Gallinas canyon, Santa Fe canyon, Magdalena mountains.
4607*a* langii Mann. Gallinas canyon.
4610 lauta Lec. Gallinas canyon, Santa Fe canyon.
4611 adjecta Lec. Gallinas canyon.
4619 Melanophila longipes Say. Gallinas canyon.
4621 drummondi Kirby. Gallinas canyon, Santa Fe canyon, Magdalena mountains.
4621 drummondi, var. Magdalena mountains.
4623 gentilis Lec. Gallinas canyon.
4628 Anthaxia æneogaster Lap. Gallinas canyon.
4634 flavimana Gory. Gallinas canyon.

Family BUPRESTIDÆ.

4639 Chrysobothris femorata Fab. Magdalena mountains, Santa Fe canyon.
4644 4-lineata Lec. Magdalena mountains, Gallinas canyon, Water canyon.
4645 texana Lec. Walnut creek.
4647 dentipes Germ. Gallinas canyon.
4650 trinervia Kirby. Gallinas canyon, Santa Fe canyon.
4662 æneola Lec. Gallinas canyon.
4664 atrofasciata Lec. Walnut creek.
10070 axillaris Horn. Magdalena mountains.
4677 Acmæodera amplicollis Lec. Water canyon.
4679 amabilis Horn. Walnut creek.
4686 miliaris Horn. Walnut creek, Santa Fe canyon, Magdalena mountains.
4692 ornata Fab. Water canyon.
4695 decipiens Lec. Walnut creek.
4698 mima Gory. Walnut creek, Water canyon.
4699 pulchella Hbst. Santa Fe canyon, Magdalena mountains, Gallinas canyon.
4707 culta Web. Gallinas canyon.
4708 4-vittata Horn. Gallinas canyon.
4716 Chrysophana placida Lec. Gallinas canyon.
4724*b* Agrilus defectus Lec. Magdalena mountains.
4732 interruptus Lec. Gallinas canyon.
4742 politus Say. Gallinas canyon.
4746 egenus Gory. Gallinas canyon.
10126 blandus Horn. Socorro.
4761 Brachys ærosa Melsh. Gallinas canyon.
4764 Pachyscelus purpureus Say. Gallinas canyon.

Family LAMPYRIDÆ.

4767 Rhyncheros sanguinipennis Say. Gallinas canyon, Magdalena mountains.
4768 Lycus cruentus Lec. Walnut creek.
4769 fernandezii Duges. Walnut creek.
4771 Lycostomus fulvellus Lec. Gallinas canyon.
4772 loripes Chev. Walnut creek.
Cænia, undetermined species. Santa Fe canyon.
4781 amplicornis Lec. Gallinas canyon.
4787 Eros aurora Hbst. Gallinas canyon, Walnut creek.
4794 Plateros modestus Say. Gallinas canyon.
4795 canaliculatus Say, var. Gallinas canyon, Walnut creek.
4796 sollicitus Lec. Magdalena mountains.
4800 Lygistopterus rubripennis Lec. Gallinas canyon.
4806 Calochromus ruficollis Lec. Gallinas canyon, Santa Fe canyon, Magdalena mountains.
4813 Ellychnia flavicollis Lec. Gallinas canyon.
4814 californica Mots. Gallinas canyon.
4815 corrusca Linn. Gallinas canyon, Santa Fe canyon.
4820 Pyropyga decipiens Harr. Water canyon.
4870 Chauliognathus limbicollis Lec. Gallinas canyon.

Family LAMPYRIDÆ.

4872 Chaulognathus scutellaris Lec. Gallinas canyon, Santa Fe canyon, Water canyon.
4873 lewisii Cr. Water canon.
4901 Podabrus piniphilus Esch. Gallinas canyon.
4902 lateralis Lec. Walnut creek.
4926 Telephorus dentiger Lec. Gallinas canyon.
4939 flavipes Lec. Gallinas canyon.
4953 tuberculatus Lec. Gallinas canyon.

Family MALACHIDÆ.

4995 Collops punctatus Lec. Water canyon.
4996 eximius Er. Gallinas canyon.
5002 bipunctatus Say. Gallinas canyon, Water canyon, Santa Fe canyon, Magdalena mountains.
5004 4-maculatus Fab., var. Santa Fe canyon.
5013 vittatus Say. Albuquerque.
5017 Trophimus æneipennis Horn. Gallinas canyon.
5051 Attalus basalis Lec. Gallinas canyon.
5055 morulus Lec. Santa Fe canyon.
5066 difficilis Lec. Gallinas canyon.
5099 Pristoscelis rufipennis Lec. Water canyon.
5100 comatus Lec. Gallinas canyon, Santa Fe canyon, Magdalena mountains.
5109 Listrus senilis Lec. Gallinas canyon, Magdalena mountains.
5117 Dasytes hudsonicus Lec. Magdalena mountains.

Family CLERIDÆ.

5131 Cymatodera puncticollis Bland. Walnut creek.
5134 cylindricollis Chev. Walnut creek, Albuquerque.
5155 Aulicus nero Spin. Water canyon.
5158 Trichodes ornatus Say. Gallinas canyon.
5158a tenellus Lec. Gallinas canyon.
5161 apivorus Germ. Santa Fe canyon, Albuquerque.
5164 Clerus spinolæ Lec. Walnut Creek.
5168 analis Lec. Water canyon.
5173 cordifer Lec. Gallinas canyon.
5177 nigriventris Lec. Gallinas canyon.
5178 sphegeus Fab. Gallinas canyon.
5179 mœstus Kl. Gallinas canyon, Magdalena mountains.
atriventris Lec. Gallinas canyon.
new species. Santa Fe canyon.
5185 Thanasimus undulatus Say. Gallinas canyon.
5189 Hydnocera unifasciata Say. Magdalena mountains.
5191 subfasciata Lec. Magdalena mountains.
5192 suberosa Spin. Magdalena mountains, Gallinas canyon.
5193 pubescens Lec. Magdalena mountains, Gallinas canyon.
5197 [illegible]oides Lec. Walnut creek.
5225 Lebasoella [illegible]oides Lec. Santa Fe canyon.
5230 Necrobia rufipes Fab. Santa Fe canyon, Water canyon, Magdalena mountains.
5232 [illegible] Linn. Gallinas canyon.

Family PTINIDÆ.

5244 Ptinus interruptus Lec. Santa Fe canyon.
Ernobius, new species. Gallinas canyon, Walnut creek.
5281 Trypopitys sericeus Say. Walnut creek.
5304 Catorama sectans Lec. Magdalena mountains.
5332 Ptilinus ruficornis Say. Walnut creek.
5334 thoracicus Rand. Magdalena mountains.

Family LUCANIDÆ.

5413 Lucanus mazama Lec. Gallinas canyon, Santa Fe canyon.
5414 placidus Say. Gallinas canyon.
5419 Platycerus depressus Lec. Santa Fe canyon.

Family SCARABÆIDÆ.

5428 Canthon praticola Lec. Santa Fe canyon, Water canyon.
5435 lævis Drury. Gallinas canyon.
5446 Copris mœchus Lec. Walnut creek.
5450 Phanæus quadridens Say. Walnut creek.
5452 carnifex Linn. Gallinas canyon, Water canyon, Socorro.
5457 Onthophagus coproides Horn. Santa Fe canyon, Water canyon.
5458 hecate Panz. Santa Fe canyon, Gallinas canyon.
5484 Rhyssemus cælatus Lec. Santa Fe canyon.
5488 Atœnius robustus Horn. Magdalena mountains.
5490 figurator Harr. Water canyon.
5491 gracilis Melsh. Albuquerque.
5499 abditus Hald. Albuquerque.
5511 Aphodius hyperboreus Lec. Santa Fe canyon.
5513 occidentalis Horn. Magdalena mountains.
5521 crassulus Horn. Santa Fe canyon.
5522 ursinus Mots. Santa Fe canyon, Gallinas canyon.
5523 ruricola Melsh. Sante Fe canyon, Water canyon.
5529 vittatus Say. Santa Fe canyon, Magdalena mountains.
5550 consentaneus Lec. Walnut creek.
5555 cruentatus Lec. Gallinas canyon.
5556 subtruncatus Lec. Gallinas canyon.
5564 coloradensis Horn. Gallinas canyon, Water canyon.
duplicatus. Santa Fe canyon, Water canyon.
undetermined species. Walnut creek.
5580 Ochodœus ulkei Horn. Gallinas canyon.
5582 frontalis Lec. Walnut creek.
5583 striatus Lec. Walnut creek.
5590 Bolboceras farctus Fab. Water canyon.
5591 lazarus Fab. Water canyon, Gallinas canyon, Albuquerque.
5612 Trox scutellaris Say. Water canyon, Albuquerque.
5616 suberosus Fab. Water canyon.
5617 puncatus Germ. Water canyon.
5618 tuberculatus De G. Magdalena mountains.
5620 sonoræ Lec. Santa Fe canyon, Gallinas canyon, Water canyon.
5630 atrox Lec. Santa Fe canyon.
5648 Hoplia laticollis Lec. Gallinas canyon.

Family Scarabæidæ.

5669 Dichelonycha sulcata Lec. Gallinas canyon.
5674 Serica vespertina Cyll. Gallinas canyon.
5677 serotina Lec. Walnut creek.
5682 curvata Lec. Walnut creek, Gallinas canyon, Magdalena mountains.
5684 mixta Lec. Gallinas canyon.
new species. Gallinas canyon.
5692 Macrodactylus uniformis Horn. Gallinas canyon, Water canyon.
5704 Diplotaxis brevicollis Lec. Santa Fe, Gallinas canyon, Water canyon.
5705 obscura Lec. Magdalena mountains, Water canyon.
5721 carbonata Lec. Albuquerque, Water canyon.
5726 haydenii Lec. Gallinas canyon.
undetermined species. Walnut creek.
5739 Lachnosterna lanceolata Say, Gallinas canyon, Water canyon.
5757 fusca Froh. Gallinas canyon.
5761 micans Knoch. Gallinas canyon.
5775 affinis Lec. Gallinas canyon.
5781 hirsuta Knoch. Gallinas canyon.
10261 vetula Horn. Gallinas canyon.
undetermined species. Gallinas canyon.
new species, near ephelida Horn. Walnut creek.
longipilis Horn. Walnut creek.
Phytalus, new species. Walnut creek.
5804 debilis Horn. Walnut creek.
5806 Listrochelus disparilis Horn. Gallinas canyon.
5817 falsus Lec. Gallinas canyon, Santa Fe canyon.
5818 fimbripes Lec. Magdalena mountains.
5820 Polyphylla hammondi Lec. Albuquerque.
5820 hammondi Lec., var. Albuquerque.
5822 decemlineata Say. Albuquerque, Gallinas canyon.
5824 crinita Lec. Walnut creek.
5842 Strigoderma arboricola Fab. Walnut creek.
5847 Pleuiotis gloriosa Lec. Walnut creek, Water canyon.
5848 lecontei Horn. Walnut creek, Water canyon.
5850 Cyclocephala immaculata Oliv. Water canyon.
5852 manca Lec. Walnut creek.
5869 Ligyrus gibbosus De G. Albuquerque, Water canyon.
5873 Aphonus pyriformis Lec. Gallinas canyon.
5874 tridentatus Say. Santa Fe canyon.
5877 chunalis Lec. Santa Fe canyon.
5878 Orthobus snowi Horn. Albuquerque, Walnut creek.
5880 Xyloryctes satyrus Fab. Walnut creek.
5883 Strategus cornus Lec. Albuquerque, Walnut creek, Water canyon.
5887 Dynastes grantii Horn. Silver City.
5888 Alburhina mutabilis Gory. Socorro.
5894 nitida Linn. Water canyon.
5896 Gymnetis cretacea Lec. Walnut creek.
5901 Euphoria kernii Hald. Gallinas canyon, Water canyon.
5906 fulgida Fab. Gallinas canyon.

Family SCARABÆIDÆ.

5911 Euphoria inda Linn. Gallinas canyon, Water canyon, Santa Fe canyon, Magdalena mountains.
undetermined species. Walnut creek.
5924 Cremastochilus crinitus Lec. Magdalena mountains.
5925 knochii Lec. Santa Fe canyon.
5939 Trichius affinis Gory. Gallinas canyon.

Family SPONDYLIDÆ.

5948 Spondylis uniformis Mann. Walnut creek.

Family CERAMBYCIDÆ.

5950 Ergates spiculatus Lec. Magdalena mountains, Gallinas canyon.
5957 Derobrachus brevicollis Serv. Water canyon.
5961 Prionus californicus Mots. Water canyon, Gallinas canyon.
5966 Homæsthesis emarginatus Say. Gallinas canyon.
5967 Tragosoma harrisii Lec. Gallinas canyon.
5973 Nothorhina aspera Lec. Gallinas canyon.
5974 Criocephalus productus Lec. Santa Fe canyon, Gallinas canyon, Magdalena mountains.
5976 asperatus Lec. Gallinas canyon.
5981 Tetropium velutinum Lec. Gallinas canyon.
5982 cinnamopterum Kirby. Gallinas canyon.
5992 Hylotrupes ligneus Fab. Walnut creek.
6002 Phymatodes dimidiatus Kirby. Gallinas canyon.
6008 Callidium antennatum Newm. Walnut creek.
6012 hirtellum Lec. Gallinas canyon.
6049 Romaleum simplicicolle Hald. Walnut creek.
6105 Rhopalophora longipes Say. Santa Fe canyon, Gallinas canyon.
6105 longipes Say., var. Santa Fe canyon, Gallinas canyon.
Pteroplatus, new species. Gallinas canyon.
6119 Dendrobias quadrimaculatus Dup. Walnut creek.
6122 Stenaspis solitaria Say. Deming.
6126 Tragidion annulatum Lec. Magdalena mountains, Gallinas canyon.
6127*a* fulvipenne Say. Magdalena mountains, Gallinas canyon, Santa Fe canyon, Water canyon.
6140 Batyle ignicollis Say. Gallinas canyon, Water canyon.
6141 pearsalli Bland., var. Gallinas canyon.
6147 Tylosis maculata Lec. Gallinas canyon, Albuquerque.
6152 Crossidius intermedius Ulke. Socorro.
6153 pulchellus Lec. Gallinas canyon, Water canyon.
6157 discoideus Say. Gallinas canyon, Socorro.
6158 Sphænothecus suturalis Lec. Deming.
Stenosphenus, undetermined species. Magdalena mountains, Walnut creek.
6172 Cyllene infaustus Lec., var. Gallinas canyon.
6172 lutosus Lec., var. Gallinas canyon, Magdalena mountains.
6174 Calloides nobilis Say. Gallinas canyon.
6180 Xylotrechus sagittatus Germ. Gallinas canyon.
6183 undulatus Say. Gallinas canyon, Magdalena mountains, Santa Fe canyon.
6183 undulatus Say., var. Santa Fe canyon.

Family CERAMBYCIDÆ.

6232 Rhagium lineatum Oliv. Gallinas canyon.
6248 Pachyta liturata Kirby. Gallinas canyon.
6267 Acmæops longicornis Kirby. Gallinas canyon.
6274 pratensis Laich. Gallinas canyon.
6286 Strangalia sexnotata Hald. Gallinas canyon.
6289 Typocerus zebratus Fab. Gallinas canyon.
6292 velutinus Oliv. Gallinas canyon.
6294 brunnicornis Lec. Gallinas canyon.
6296 sinuatus Newm. Gallinas canyon.
6330 Leptura nigrella Say, var. Gallinas canyon.
6331 carbonata Lec. Gallinas canyon.
6332*b* cribripennis Lec. Gallinas canyon, Santa Fe canyon.
6337 sanguinea Lec. Gallinas canyon.
6341 chrysocoma Kirby. Gallinas canyon.
6342 nigrolineata Bland. Gallinas canyon, Walnut creek.
6361 mutabilis Newm. Gallinas canyon.
6369 Monilema annulatum Say. Gallinas canyon.
6370 appressum Lec. Magdalena mountains.
6373 lævigatum Bland. Santa Fe canyon.
6381 crassum Lec. Gallinas canyon.
6386 Monohammus maculosus Hald. Gallinas canyon, Santa Fe canyon.
6387 scutellatus Say. Gallinas canyon.
6418 Leptostylus biustus Lec. Walnut creek.
undetermined species. Walnut creek.
6433 Dectes spinosus Say. Gallinas canyon.
6441 Hyperplatys maculatus Hald. Gallinas canyon.
6446 Acanthocinus obliquus Lec. Gallinas canyon, Santa Fe canyon.
6447 spectabilis Lec. Gallinas canyon, Santa Fe canyon.
6453 Pogonocherus mixtus Hald. Gallinas canyon, Santa Fe canyon, Magdalena mountains.
6478 Saperda calcarata Say. Gallinas canyon.
6492 Mecas pergrata Say. Gallinas canyon.
6509 Tetraopes discoideus Lec. Gallinas canyon.
6513 femoratus Lec. Gallinas canyon.
6513*b* basalis Lec. Gallinas canyon.
6515 canescens Lec. Gallinas canyon.

Family CHRYSOMELIDÆ.

10331 Aulacoscelis purpurea Horn. Magdalena mountains.
undetermined species. Walnut creek.
6550 Orsodachna atra Ahr., var. childreni Kirby. Gallinas canyon.
6550 var. trivittata Lec. Walnut creek.
6550 unnamed variety. Gallinas canyon.
6552 Zeugophora abnormis Lec. Gallinas canyon, Magdalena mountains.
6556 consanguinea Cr. Gallinas canyon.
6558 Syneta carinata Mann. Gallinas canyon.
6563 Lema concolor Lec. Gallinas canyon.
6573 trilineata Oliv. Gallinas canyon.
6573 trilineata Oliv., var. trivirgata Lec. Gallinas canyon.
new species. Gallinas canyon.

Family CHRYSOMELIDÆ.

6579 Anomœa laticlavia Forst. Gallinas canyon.
6587 Coscinoptera axillaris Lec. Magdalena mountains.
6592 vittigera Lec., var. arizonensis.
6596 Babia 4-guttata Oliv. Gallinas canyon.
6596*b* 4-guttata Oliv., var. tetraspilota Lec. Magdalena mountains, Walnut creek.
6598 Saxinis omogera Lec. Gallinas canyon.
6600 Urodera crucifera Lec. Gallinas canyon, Magdalena mountains.
6605 Exema conspersa Mann. Socorro, Walnut creek.
6617*a* Cryptocephalus quadriplex Newm., var. 4-guttulus Suffr. Gallinas canyon.
6624 amatus Hald. Walnut creek.
6626 confluens Say. Socorro, Magdalena mountains.
new species. Magdalena mountains.
6653? Pachybrachys xanti Cr. Walnut creek.
6655 morosus Hald. Gallinas canyon.
6659 litigiosus Suffr. Gallinas canyon.
6660 abdominalis Say., var. Walnut creek.
6661 dubiosus Lec. Gallinas canyon.
6673 tridens Melsh. Gallinas canyon.
6687 subvittatus Lec. Gallinas canyon.
6690 atomarius Melsh. Gallinas canyon, Magdalena mountains.
6697 hepaticus Melsh. Gallinas canyon.
undetermined species. Magdalena mountains.
two new species. Gallinas canyon.
6707 Diachus auratus Fab. Gallinas canyon, Walnut creek.
6720 Xanthonia 10-notata Say. Gallinas canyon, Santa Fe canyon.
Heteraspis marcassita Germ. Santa Fe canyon.
6741 Chrysochus auratus Fab. Gallinas canyon.
6748 Paria atterima Oliv. Gallinas canyon.
6769 Graphops marcassita Cr. Santa Fe canyon.
undetermined species. Magdalena mountains.
6789 Doryphora 10-lineata Say. Magdalena mountains.
new species. Gallinas canyon.
6794 rubiginosa Rog. Water canyon.
6795 Chrysomela exclamationis Fab. Gallinas canyon.
6796 conjuncta Rog. Gallinas canyon.
6798 continua Lec. Gallinas canyon.
6799 suturalis Fab. Gallinas canyon.
6810 multipunctata Say. Gallinas canyon.
6813 tortuosa Rog. Walnut creek.
6815 serpentina Rog. Walnut creek.
6816 multiguttata Stal. Walnut creek.
6821 auripennis Say. Gallinas canyon.
new species. Gallinas canyon.
6828 Plagiodera viridis Melsh. Gallinas canyon, Water canyon.
6836 Lina arizonæ Cr. Walnut creek.
6837 lapponica Linn. Magdalena mountains.
6839 scripta Fab. Magdalena mountains.

Family CHRYSOMELIDÆ.

6861 Luperus varicornis Lec. Walnut creek.
6867 lecontei Cr. Gallinas canyon.
6869 longulus Lec. Gallinas canyon.
6879 Diabrotica tricincta Say. Socorro.
6881 12-punctata Oliv. Socorro.
6881*a* tenella Lec. Magdalena mountains.
6884 blandula Lec. Gallinas canyon.
6888 longicornis Say. Socorro.
6889 lemniscata Lec. Socorro.
6891 atripennis Say. Gallinas canyon.
6892*b* Trirhabda canadensis Kirby. Gallinas canyon.
6895 convergens Lec. Walnut creek.
6898 Adimonia externa Say. Gallinas canyon.
6899 americana Fab. Gallinas canyon.
6899*a* cribrata Lec. Gallinas canyon.
6904 Galeruca tuberculata Say. Gallinas canyon.
6916 Monoxia guttulata Lec. Santa Fe canyon, Gallinas canyon.
10407 debilis Lec. Magdalena mountains.
puncticollis Say. Albuquerque.
6933 Œdionychis lugens Lec. Gallinas canyon.
6942 texana Cr. Gallinas canyon.
6948 Disonycha alternata Ill. Socorro, Gallinas canyon.
6949 punctigera Lec. Walnut creek.
6954 abbreviata Melsh. Gallinas canyon.
10419 politula Horn. Gallinas canyon.
6957 triangularis Say. Gallinas canyon.
6958 xanthomelæna Dalm. Gallinas canyon.
6958*c* semicarbonata Lec. Magdalena mountains.
10416 crenicollis Say. Albuquerque.
6960 Haltica bimarginata Say. Albuquerque, Santa Fe canyon.
6962 carinata Germ. Gallinas canyon, Socorro.
6972 punctipennis Lec. Gallinas canyon, Magdalena mountains.
6973 lazulina Lec. Albuquerque.
undetermined species. Socorro.
three undetermined species. Gallinas canyon.
6987 Crepidodera cucumeris Harr. Gallinas canyon, Magdalena mountains.
6991 parvula Fab. Soccoro.
7002 Systena marginalis Ill. Gallinas canyon.
7002 marginalis, var. oblonga Lec. Gallinas canyon.
7003 blanda Melsh. Magdalena mountains, Gallinas canyon.
Longitarsus vanus Horn. Magdalena mountains.
three undetermined species. Gallinas canyon.
7016 Glyptina spuria Lec. Gallinas canyon.
atriventris Horn. Socorro.
new species. Gallinas canyon.
7027 Phyllotreta albionica Lec. Gallinas canyon.
10458 pusilla Horn. Socorro.
7040 Chætocnema denticulata Ill. Santa Fe canyon.
7046 subviridis Lec. Gallinas canyon.
7049 crenulata Cr. Gallinas canyon.

Family CHRYSOMELIDÆ.

7058 Psylliodes punctulata Melsh. Socorro.
7060 Microrhopala vittata Fab. Albuquerque.
7064 vulnerata Horn. Walnut creek.
7073 Odontota collaris Say. Walnut creek.
7074 omogera Cr. Walnut creek.
7077 bicolor Oliv. Gallinas canyon.
7082 nervosa Panz. Gallinas canyon.
7086 Charistena perspicua Horn. Walnut creek.
new species. Walnut creek.
7091 Octotoma marginicollis Horn. Walnut creek.
7097 Cassida nigripes Oliv. Gallinas canyon.
7102 Coptocycla aurichalcea Fab. Gallinas canyon.

Family BRUCHIDÆ.

7135 Bruchus aureolus Horn. Gallinas canyon.
7137 prosopis Lec. Socorro.

Family TENEBRIONIDÆ.

7167 Edrotes rotundus Say. Magdalena mountains.
7196 Emmenastus acutus Horn. Magdalena mountains, Gallinas canyon.
7199 obtusus Lec. Gallinas canyon.
undetermined species. Socorro.
7203 Epitragus canaliculatus Say. Santa Fe canyon.
7217 Zopherus concolor Lec. Gallinas canyon.
Eurymetopon new species. Gallinas canyon.
7229 Aræoschizus costipennis Lec. Magdalena mountains.
7250 Microschatia morata Horn. Gallinas canyon.
7253 Astrotus regularis Horn. Water canyon.
7254 Asida opaca Say. Gallinas canyon, Water canyon, Santa Fe canyon, Socorro, Magdalena mountains.
7257 polita Say. Gallinas canyon, Water canyon.
7259 sordida Lec. Gallinas canyon, Water canyon.
7261 morbillosa Lec. Water canyon.
blapsoides Sol. Magdalena mountains, Water canyon.
7281 convexa Lec. Water canyon.
7283 convexicollis Lec. Water canyon.
7284 marginata Lec. Water canyon, Santa Fe canyon.
7284*a* rimata Lec. Deming, Water canyon.
7286 elata Lec. Water canyon.
7287 macra Horn. Walnut creek.
new species. Water canyon.
7298 Coniontis ovalis Esch. Magdalena mountains.
7307 Eusattas reticulatus Say. Water canyon.
7315 muricatus Lec. Walnut creek.
7316 Eleodes obscura Say. Gallinas canyon, Water canyon.
7316*a* dispersa Lec. Gallinas canyon, Water canyon, Santa Fe canyon, Magdalena mountains.
7318 suturalis Say. Albuquerque, Water canyon.
7318*a* texana Lec. Gallinas canyon.
7320 tricostata Say. Gallinas canyon.
7322 carbonaria Say. Magdalena mountains, Water canyon.

Family TENEBRIONIDÆ.

7322 carbonaria Say, form debilis. Water canyon.
7322 carbonaria Say, form soror. Water canyon.
7323 obsoleta Say. Gallinas canyon. Water canyon.
7324 quadricollis Esch. Santa Fe canyon.
7327 extricata Say. Santa Fe canyon, Water canyon, Gallinas canyon.
7331 longicollis Lec. Water canyon, Socorro, Magadelena mountains.
7333 vertricosa Lec. Water canyon.
7335 gracilis Lec. Water canyon, Magdalena mountains.
7339 nigrina Lec. Santa Fe canyon, Magdalena mountains.
7340 hispilabris Say. Gallinas canyon.
7341 sponsa Lec. Gallinas canyon, Albuquerque, Socorro.
7342 caudifera Lec. Magdalena mountains, Water canyon.
7351 consobrina Lec. Magdalena mountains, Santa Fe canyon.
7353 planipennis Lec. Magdalena mountains, Santa Fe canyon, Water canyon.
7355 cordata Esch. Gallinas canyon.
7385 Embaphion contusum Lec. Santa Fe canyon.
7380 Argoporis bicolor Lec. Magdalena mountains.
7394 Iphthimus serratus Mann. Santa Fe canyon, Gallinas canyon.
7394 serratus Mann, var. Walnut creek.
7420 Bius estriatus Lec. Walnut creek.
7438 Blapstinus pratensis Lec. Santa Fe canyon, Gallinas canyon.
7442 mœstus Melsh. Magdalena mountains.
7457 Ulus crassus Lec. Water canyon.
undetermined species. Water canyon.
10617 Tribolium confusum Duv. Socorro.
7519 Platydema oregonense Lec. Gallinas canyon.
undetermined species. Santa Fe canyon.
7532 Hypophlœus parallelus Melsh. Gallinas canyon.
7564 Helops convexulus Lec. Gallinas canyon.
7568 arizonensis Horn. Walnut creek.

Family CISTELIDÆ.

Allecula, two undetermined species. Walnut creek.
new species. Gallinas canyon.
7592 Hymenorus obscurus Say. Santa Fe canyon.
undetermined species. Magdalena mountains.
undetermined species. Albuquerque.
7603 Cistela pinguis Lec. Gallinas canyon.
7622 Mycetochares lugubris Lec. Santa Fe canyon.

Family OTHNIIDÆ.

7633 Othnius umbrosus Lec. Santa Fe canyon.

Family LAGRIIDÆ.

Statira, new species, near resplendens Lec. Gallinas canyon.

Family MONOMMIDÆ.

7644 Hyporhagus opuntiæ Horn. Magdalena mountains.

Family MELANDRYIDÆ.

7648 Tetratoma concolor Lec. Gallinas canyon.
7659 Zilora hispida Lec. Santa Fe canyon.
7661 Carebara longula Lec. Gallinas canyon.
7666 Serropalpus barbatus Schall. Santa Fe canyon.
7677 Eustrophus indistinctus Lec. Walnut creek.
7684 Hallomenus punctulatus Lec. Santa Fe canyon.
7701 Lacconotus pinicolus Horn. Gallinas canyon.
7704 Myceterus concolor Lec. Gallinas canyon.
new species. Gallinas canyon.

Family PYTHIDÆ.

7707 Crymodes discicollis Lec. Gallinas canyon.
7717 Salpingus virescens Dec. Gallinas canyon.

Family ŒDEMERIDÆ.

7730 Ditylus obscurus Lec. Gallinas canyon.
undetermined species. Santa Fe canyon.
7740 Oxacis pallida Lec. Albuquerque.
undetermined species. Albuquerque.

Family MORDELLIDÆ.

7761 Pentaria trifasciata Melsh. Socorro.
7762 fuscula Lec. Magdalena mountains.
7765 Anaspis nigra Hald. Santa Fe canyon.
7766 atra Lec. Gallinas canyon.
7770 rufa Say. Gallinas canyon, Magdalena mountains.
7771 pusio Lec. Gallinas canyon.
7780 Mordella scutellaris Fab. Gallinas canyon.
7788 insulata Lec. Gallinas canyon.
7816 Mordellistena comata Lec. Magdelena mountains.
7833 nigricans Melsh. Magdelena mountains.
7863 angusta Lec. Santa Fe canyon.

Family ANTHICIDÆ.

7911 Xylophilus piceus Lec. Gallinas canyon.
7919 Notoxus bifasciatus Lec. Walnut creek.
new species. Gallinas canyon.
7945 Anthicus floralis Linn. Santa Fe canyon.

Family MELOIDÆ.

7999 Cysteodemus wislizeni Lec. Albuquerque, Socorro.
8000 Megetra vittata Lec. Socorro.
8015 Meloe sublævis Lec. Gallinas canyon, Socorro.
undetermined species, near rugipennis, Lec. Santa Fe canyoh.
8024 Nemognatha lurida Lec. Santa Fe canyon.
8024 lurida Lec., var. Santa Fe canyon.
8025 apicalis Lec. Walnut creek.
8026 lutea Lec. Gallinas canyon.
8027 bicolor Lec. Gallinas canyon, Santa Fe canyon.
8033 nigripennis Lec. Gallinas canyon.
8035 cribraria Lec. Gallinas canyon, Santa Fe canyon.

Family MELOIDÆ.

8037 Nemognatha immaculata Say. Gallinas canyon, Santa Fe canyon, Albuquerque.
8038 punctipennis Lec. Walnut creek.
8039 sparsa Lec. Albuquerque, Socorro.
8041 cribricollis Lec. Socorro, Gallinas canyon.
8042 Gnathium francilloni Kirby. Walnut creek.
8046 nitidium Horn. Walnut creek.
8047 Zonitis atripennis Say. Albuquerque, Santa Fe canyon.
8048 flavida Lec. Albuquerque, Santa Fe canyon.
8049 bilineata Say. Gallinas canyon.
8051 rufa Lec. Gallinas canyon.
8056 Macrobasis longicollis Lec. Walnut creek.
8057 atrivittata Lec. Albuquerque.
8061 unicolor Kirby. Gallinas canyon.
8064 ochrea Lec. Walnut creek.
8072 Tetraonyx fulva Lec. Gallinas canyon.
8074 Pleuropompha costata Lec. Deming, Albuquerque.
8082 Epicauta ferruginea Say. Gallinas canyon, Socorro.
8083 sericans Lec. Gallinas canyon.
8091 pardalis Lec. Gallinas canyon.
8103 corvina Lec. Socorro, Magdalena mountains.
8104 pennsylvanica De G. Albuquerque, Gallinas canyon.
8107 Pyrota mylabrina Chev. Socorro.
8117 lineata Oliv. Albuquerque.
8126 Cantharis mutilata Horn. Socorro.
8130 deserticola Horn. Walnut creek.
8131*a* cooperi Lec. Walnut creek.
8132 nuttalli Say. Gallinas canyon.
8139 biguttata Lec. Socorro, Gallinas canyon, Albuquerque.
new species. Walnut creek.
8169 Eupompha fissiceps Lec. Socorro.

Family RHIPIPHORIDÆ.

8177 Rhipiphorus pectinatus Fal. Gallinas canyon.
8183 Myodites scaber Lec. Socorro.

Family RHYNCHITIDÆ.

8210 Rhynchites bicolor Fab. Gallinas canyon.
8211 æneus Boh. Gallinas canyon.
8222 æratus Say. Magdalena mountains.

Family OTIORHYNCHIDÆ.

8233 Epicærus imbricatus Say. Walnut creek.
8242 Ophryastes vittatus Say. Gallinas canyon.
8245 sulcirostris Say. Gallinas canyon.
Eupagoderes, undetermined species, Magdalena mauntains.
8249 sordidus Lec. Magdalena mountains.
8258 Anametis grisea Horn. Gallinas canyon.
8262 Orimodema protracta Horn. Magdalena mountains.
8266 Peritaxia rugicollis Horn. Magdalena mountains, Santa Fe canyon, Gallinas canyon.

Family OTIORHYNCHIDÆ.

Amnesia, undetermined species. Magdalena mountains.
8294 Thricolepis inornata Horn. Magdalena mountains, Gallinas canyon.
8311 Tanymecus lacæna Hbst. Walnut creek.
8314 Pandeletejus hilaris Hbst. Santa Fe canyon, Gallinas canyon.
8317 Cyphus lautus Lec. Deming.
8323 Phacepholis elegans Horn. Gallinas canyon.
8325 candida Horn. Gallinas canyon, Walnut creek.

Family CURCULIONIDÆ.

8348 Sitones tibialis Hbst. Gallinas canyon.
Acmægenius, undetermined species. Walnut creek.
8360 Lepidophorus lineaticollis Kirby. Gallinas canyon.
Apion, undetermined species. Gallinas canyon.
undetermined species. Magdalena mountains.
undetermined species. Albuquerque.
8429 Phytonomus setigerus Lec. Gallinas canyon.
8515 Cleonopsis pulvereus Lec. Walnut creek.
8520 Cleonus frontalis Lec. Gallinas canyon, Santa Fe canyon.
8522 quadrilineatus Chev. Walnut creek.
8524 puberulus Lec. Walnut creek.
8526 vittatus Kirby. Gallinas canyon, Magdalena mountains.
8532 Dorytomus brevicollis Lec. Santa Fe canyon.
undetermined species. Gallinas canyon.
8544 Procas lecontei Bedel. Walnut creek.
8546 Desmoris constrictus Say. Albuquerque, Gallinas canyon.
8558 Smicronyx fulvus Lec. Albuquerque, Gallinas canyon.
10927 instabilis Casey. Socorro, Magdalena mountains.
8603 Otidocephalus vittatus Horn. Walnut creek.
8612 Magdalis cuneiformis Horn. Gallinas canyon, Santa Fe canyon.
8613 lecontei Horn. Gallinas canyon.
8630 Anthonomus quadrigibbus Say. Walnut creek.
8642 rufipennis Lec. Gallinas canyon.
8652 squamosus Lec. Gallinas canyon.
8654 hirtus Lec. Magdalena mountains.
8677 Orchestes niger Horn. Gallinas canyon.
8711 Læmosaccus plagiatus Fab. Gallinas canyon, Magdalena mountains.
8742 Rhyssematus lineaticollis Say. Gallinas canyon, Socorro.
8761 Acalles turbidus Lec. Gallinas canyon.
Cryptorhynchus, undetermined species. Walnut creek.
8804 Zascelis irrorata Lec. Walnut creek, Gallinas canyon.
8811 Copturus operculatus Say. Gallinas canyon.
8846 Ceutorhynchus squamatus Lec. Socorro.
undetermined species. Magdalena mountains, Socorro.
undetermined species. Magdalena mountains.
8866 Orthoris crotchii Lec. Gallinas canyon.
8868 Baris strenua Lec. Gallinas canyon.
undetermined species. Walnut creek.
8872 transversa Say. Magdalena mountains.
Pseudobaris, undetermined species. Walnut creek.
8899 Onychobaris cribrata Lec. Gallinas canyon.

Family CURCULIONIDÆ.

8926 Centrinus neglectus Lec. Gallinas canyon.
8928 picumnus Hbst. Gallinas canyon.
8960 Balaninus uniformis Lec. Santa Fe canyon.
8961 nasicus Say. Water canyon.

Family CALANDRIDÆ.

8973 Scyphophorus acupunctatus Gyll. Magdalena mountains.
8979 Rhodobænus pustulosus Gyll. Walnut creek.
8982 Sphenophorus ulkei Horn. Santa Fe canyon.
9014 Yuccaborus frontalis Lec. Magdalena mountains.
9024 Cossonus subareatus Boh. Magdalena mountains.
9026 concinnus Boh. Gallinas canyon, Santa Fe canyon.
9044 Rhyncholus brunneus Mann. Magdalena mountains, Santa Fe canyon.
undetermined species. Santa Fe canyon.

Family SCOLYTIDÆ.

Platypus, new species. Santa Fe canyon.
9059 Pityophthorus retusus Lec. Gallinas canyon, Socorro.
9079 puncticollis Lec. Gallinas canyon, Walnut creek.
new species. Walnut creek.
9093 Xyloterus bivittatus Kirby. Gallinas canyon.
9094 scabricollis Lec. Gallinas canyon.
9110 Xyleborus xylographus Say. Walnut creek.
9125 Tomicus plastographus Lec. Walnut creek, Magdalena mountains.
9127 rectus Lec. Walnut creek.
9147 Scolytus californicus Lec. Santa Fe canyon, Gallinas canyon.
9149 præceps Lec. Socorro.
9157 Polygraphus rufipennis Kirby. Walnut creek.
9179 Dendroctonus terebrans Oliv. Santa Fe canyon, Gallinas canyon.
9180 similis Lec. Walnut creek, Gallinas canyon.
9183 simplex Lec. Walnut creek, Gallinas canyon.
9190 Hylastes longus Lec. Gallinas canyon.
9194 gracilis Lec. Santa Fe canyon.
new species, near tenuis. Gallinas canyon.
9200 Hylurgops rugipennis Mann. Santa Fe canyon, Gallinas canyon.
undetermined species. Water canyon, Gallinas canyon.

Family ANTHRIBIDÆ.

9207 Allandrus bifasciatus Lec. Gallinas canyon.

SUMMARY OF FAMILIES AND SPECIES.

Cicindelidæ	24	Lampyridæ	25
Carabidæ	124	Malachidæ	13
Amphizoidæ	1	Cleridæ	23
Haliplidæ	1	Ptinidæ	6
Dytiscidæ	21	Lucanidæ	3
Hydrophilidæ	16	Scarabæidæ	89
Silphidæ	7	Spondylidæ	1
Staphylinidæ	48	Cerambycidæ	71
Trichopterygidæ	1	Chrysomelidæ	127
Phalacridæ	5	Bruchidæ	2
Coccinellidæ	25	Tenebrionidæ	61
Endomychidæ	3	Cistelidæ	7
Erotylidæ	2	Othniidæ	1
Colydiidæ	1	Lagriidæ	1
Cucujidæ	1	Monommidæ	1
Cryptophagidæ	4	Melandryidæ	9
Mycetophagidæ	1	Pythidæ	2
Dermestidæ	8	Œdemeridæ	4
Histeridæ	13	Mordellidæ	11
Nitidulidæ	18	Anthicidæ	4
Latridiidæ	5	Meloidæ	41
Trogositidæ	6	Rhipiphoridæ	2
Byrrhidæ	3	Rhynchitidæ	3
Parnidæ	4	Otiorhynchidæ	15
Dascyllidæ	1	Curculionidæ	45
Rhipiceridæ	1	Calandridæ	8
Elateridæ	27	Scolytidæ	20
Buprestidæ	43	Anthribidæ	1

Totals: Families, 56; species, 1010.

CONTRIBUTIONS TOWARDS A CATALOGUE OF THE INSECTS OF KANSAS.

Results of Personal Collecting.

By ELBERT S. TUCKER, Museum Assistant in Systematic Entomology, University of Kansas, Lawrence.

ADDITIONS TO THE KANSAS LIST OF HEMIPTERA-HETEROPTERA.

THE names of forty-eight species or varieties of Hemiptera-Heteroptera are hereby added to the Kansas list which was begun by Prof. E. A. Popenoe in Transactions Kansas Academy of Science, volume IX, pages 62, 63, and recently enlarged by Mr. F. F. Crevecœur, *loc. cit.*, volume XIX, pages 232–234.

All the specimens were collected in Douglas county, except in one instance, which is especially denoted.

Family PENTATOMIDÆ.

(Subfamily *Cydninæ.*)

Cydnus obliquus Uhl. April.
Pangæus uhleri Signoret. May, June, July, October.

(Subfamily *Pentatominæ.*)

Brochymena quadrupustulata Fab. April, August.
Pentatoma ligata Stal. April, October.
Euschistus tristigmus Say, var. pyrrhocerus H.-Sch. July; July, twilight; August.
Menecles insertus Say. April, November.

Family COREIDÆ.

Archimerus calcarator Fab. June; June, twilight.
Acanthocephala instabilis Uhl. October.
terminalis Dallas. June, October.
Leptoglossus oppositus Say. October; October, twilight; November; November, twilight.
Alydus eurinus Say. August.
pilosulus H.-Sch. August.
Harmostes fraterculus Stal. August.
Corizus nigristernum Signoret. May, July.
sidæ Fab. August, on cockle-bur blossoms.

Family LYGÆIDÆ.

Nysius minutus Uhl. July; August; August, at night. Also in Sedgwick county; September.
Belonochilus numenius Say. November.
Phlegyas annulicrus Stal. May, at night.
Sphragisticus nebulosus Fal. August, at night.
Eremocoris ferus Say. August, October.

Family TINGIDÆ.

Corythuca pergandei Heid. May, at night (metatype); October.

Family ARADIDÆ.

Aradus quadrilineatus Say. May.

Family REDUVIDÆ.

Oncerotrachelus acuminatus Say. May.
Pygolampis pectoralis Say. June and July, all at electric light.
Stenopoda culiciformis Fab. July, at street lamp.
Reduvius personatus Linn. May, at night; June, at night; July; August.
Acholla multispinosa De G. July; July, twilight; August; September; October.
Sinea raptoria Stal. June.
Reduviolus pallescens Reut. May, at night.

Family CAPSIDÆ.

Psallus delicatus Uhl. May.
Plagiognathus politus Uhl. June; June, twilight; July, at night; September.
annulatus Uhl. May; June, twilight; August.
Orthotylus flavosparsus Sahl. July, August.
diaphanus Kirsch. Identified by Mr. Otto Heidemann as "probably" this species. June, twilight.
Ceratocapsus (Melinna) fasciatus Uhl. August; August, twilight.
lutescens Reut. August.
Ilnacora (subgenus Corinala) stalii Reut. May, June, August, September.
(Sthenarops) chloris Uhl. June.
malina Uhl. June.
Lygus distantii Atk. (= scutellatus Distant). May, immature; July.
invitus Say, dark variety. June.
monachus Uhl., var. May, June.
plagiatus Uhl. April.
Miridius, not recognizable. August, at night.
Stenodema (Miris) instabilis Uhl. (= affinis Reut.) April, June.

Callimiris tarsalis Reut. July; August, at electric light.

Family BELOSTOMATIDÆ.

Benacus haldemanum (Leidy) Stal. (= grisea Say.) May and July, all at electric light.
Amorgius uhleri Mont. July, at electric light.

ADDITIONS TO THE KANSAS LIST OF HEMIPTERA-HOMOPTERA.

The number of species, including named varieties, hereby added to the Kansas list of Hemiptera-Homoptera is forty-one. With few exceptions, which are fully denoted in each case, all the specimens were collected in Douglas county.

Family CICADIDÆ.

Cicada tibicen Linn. July to first week in October. Also in Sedgwick county, August.

Family MEMBRACIDÆ.

Entylia sinuata Fab., var. bactriana Germ. May; June, twilight.
Ceresa taurina Fitch. June, July.
Stictocephala inermis Fab. August.
Telamona ampelopsidis Harr. June, twilight.
Acutalis calva Say. June.

Family FULGORIDÆ.

Scolops grossus Uhl. July.
Amalopota fitchi Van D. July, at night; August, at night.
Anotia kirkaldyi Ball. August, at night.
Oliarus complectus Ball. June, twilight.
Liburnia lutulenta Van D. April.
ornata Stal. July, twilight; August, twilight.

Family JASSIDÆ.

Idiocerus moniliferæ O. & B. June.
nervatus Van D. April.
snowi G. & B. June, at electric light.
suturalis Fitch. June, at electric light.
Agallia constricta Van D. April; June, twilight; July; July, twilight; August.
Tettigonia hieroglyphica Say, var. dolobrata Ball. June.
Dræculacephala angulifera Wlk. Sedgwick county; June.
Gypona dorsalis Spang. August.
octolineata Say, var. flavilineata Fitch. June; June, at night; July, at electric light and at night; September, at electric light and at night.
Paramesus twiningi Uhl. September, at night.
Platymetopius acutus Say. October.
Deltocephalus nigrifrons Forbes. April; May; May, twilight; July; August.
sylvestris O. & B. May, July.
weedi Van D. June, twilight; August.
Phlepsius decorus O. & B. July, September.
Scaphoideus scalaris Van D. July.
Thamnotettix longula G. & B. April.
fitchi Van D. July.
Gnathodus impictus Van D. June.
Empoasca albolinea Gill. July and September, all at electric light.
viridescens Walsh. May; June, twilight; July; August.
Dicranocara fieberi Loew. May, at night; July.
Typhlocyba rosæ Harr. May, at lamplight; July; August.

Family PSYLLIDÆ.

Aphalara polygoni Foerst. September.
Pachypsylla celtidis-asteriscus Riley. April.
celtidis-mama Riley. March, April, October.
celtidis-minuta Riley. Sedgwick county; April.

Family APHIDIDÆ.

Schizoneura americana Riley. August.
Lachnus longistigma Monell. May, November.

ADDITIONS TO THE KANSAS LIST OF ORTHOPTERA.

If the paper by Mr. F. B. Isely entitled "Notes on Kansas Orthoptera," which was published in Transactions of the Kansas Academy of Science, volume XIX, pages 238–249, be generally regarded as the first state list of the orthopterous insects, the additions which I offer herewith will relate to 26 additional species.

The locality for each species taken, unless especially denoted, was Lawrence, Douglas county.

Family BLATTIDÆ.

Ischnoptera bolliana Saus. June, at night and at electric light; July.
uhleriana Saus. June, and June at electric light.
Themnopteryx deropeltiformis Brun. January, in house; March; April; June, at night.

Family ACRIDIIDÆ.

Paratettix toltecus Saus. May.
Tettigidea lateralis Say. April.
Orphulella pelidna Burm. September.
Arphia carinata Scud. August, at electric light. Also in Sedgwick county; August.
conspersa Scud. Data lost, but Douglas county.
infernalis Saus. April.
Dissosteira longipennis Thom. Sedgwick county; August, and August, at electric light.
Trimerotropis citrina Scud., var. isabelline McNeill. June, at electric light.
Campylacantha acutipennis Scud. October.

Family LOCUSTIDÆ.

Amblycorypha scudderi Brun. July.
Cyrtophyllus perspicillatus Linne. August, at night, captured by aid of light of lantern high up in elm tree.
Conocephalus triops Linne. September, at electric light.
Orchelimum volantum McNeill. July, at electric light.
Xiphidium brevipenne Scud. September.
Ceuthopilus bruneri Scud. June (nymph). Sedgwick county; data lost.
inquinatus Scud. September.
tuckeri Rehn. New species. October, at night.
Udeopsylla robusta Hald. Sedgwick county, on farm; data lost.

Family GRYLLIDÆ.

Tridactylus apicalis Say. May, along sandy banks of Kansas river.
Ellipes minuta Scud. May, along sandy banks of Kansas river.
Gryllus luctuosus A.-Serv. June and July, all at electric light.
Xabea bipunctata De G. August, at electric light.
Hapithes agitator Uhl. August, colony on ailantus bush.

A PRELIMINARY LIST OF THE NEUROPTEROUS INSECTS OF KANSAS.

No attempt has been made hitherto towards publishing a list of the neuropterous insects found in Kansas. Consequently, if the present list be duly considered as forming a preliminary state list, a beginning is made, with fifty-eight species and one variety.

ORDER *EPHEMERIDA.*

Family EPHEMERIDÆ.

All of the specimens were collected at electric light on or near bridge across the Kansas river at Lawrence, except in one instance, which is denoted.

Polymitarchys albus Say. July and August.
Hexagenia bilineata Say. July and September.
venusta Eaton. July and August.
Pentagenia quadripunctata Walsh. June, July, and August.
Siphlurus, species probably new. June and July. The only male imago was taken in July, in daytime, at a distance of more than a mile from the river.
Heptagenia pulchella Walsh. June and July.
Rithogenia elegantula Eaton. July.
Cænis diminuta Wlk. July to September.

ORDER *PLECOPTERA.*

Family PERLIDÆ.

With few exceptions, which are denoted in each ease, the specimens were collected at electric light on bridge across the Kansas river at Lawrence.

Acroneuria ruralis Hagen. July.
Perla ephyre Newm. July, at electric light in town, away from river; August, found resting in daytime.
flavescens Walsh. Last week of June, at electric light one mile from river; July, found resting in daytime; and July, at electric light on bridge.
lurida Hagen. July.
Perla xanthenes Newm. July, at electric light in town; August, at electric light on bridge.
Perlinella placida Hagen. July.
species probably new. August, found resting in daytime more than a mile from the river.
Pseudoperla occipitalis Pictet. July.
Chloroperla bilineata Say. May.
Capnia pygmæa Burm. April, on bank of Kansas river.

ORDER *ODONATA.*

All Douglas county specimens.

Family CALOPTERYGIDÆ.

Calopteryx maculata Palisot de Beauvois. June.
Hetærina basalis Hagen. August.

Family AGRIONIDÆ.

Lestes forcipatus Rambur. May, at night.
rectangularis Say. August.
unguiculatus Hagen. June, August.
Enallagma civile Hagen. June.
Ischnura verticalis Say. May, June.

Family GOMPHIDÆ.

Herpetogomphus designatus Selys. July.
Gomphus amnisola Walsh. June.

Family ÆSCHNIDÆ.

Anax junius Drury. May, August.

Family LIBELLULIDÆ.

Perithemis domitia Drury. July.
Celithemis eponina Drury. July.
Sympetrum corruptum Hagen. October.
rubicundulum Say. September.
rubicundulum Say, var. assimilatum Uhl. September.
vicinum Hagen. July.
Pachydiplax longipennis Burm. September.

ORDER *ISOPTERA.*

Family TERMITIDÆ.

Termes flavipes Koll. Douglas county, July, from rotten oak stringers in sidewalk.

ORDER *CORRODENTIA.*

Specimens taken in Douglas county.

Family PSOCIDÆ.

Pterodela pedicularia Linne. September.

Family ATROPIDÆ.

Atrops divinatoria Fab. September, October, November.

ORDER *NEUROPTERA.*

Unless especially mentioned, specimens were taken in Douglas county.

Family SIALIDÆ.

Chauliodes rasticornis Rambur. May, at electric light near river.
Corydalis cornuta Linne. July and August, all at electric light, usually near river. Larvæ collected in July.

Family CHRYSOPIDÆ.

Chrysopa nigricornis Burm. April, at electric light; June; October.
oculata Say. May; June, twilight; July; July, twilight. Also in Sedgwick county; August.
plorabunda Fitch. April; June; July, at night; August; August, at night; November. Also in Sedgwick county; August.
rufilabris Burm. July, twilight; August, at night.

Family HEMEROBIDÆ.

Hemerobius stigmaterus Fitch. April; May; May, at night; August, at night; September, at night; October.
Sympherobius amiculus Fitch. June.
perparvus McLach. April, at lamp light.

Family MYRMELEONIDÆ.

Brachynemurus abdominalis Say. August; August, at night. Also in Sedgwick county; August.

Family CONIOPTERYGIDÆ.

Coniopteryx vicina Hagen. May.

ORDER *MECOPTERA.*

Douglas county specimens.

Family PANORPIDÆ.

Bittacus stigmaterus Say. July, at night; August.
strigosus Hagen. June, July.

ORDER *TRICHOPTERA.*

All except the first species and some examples of the last were collected at electric light on the bridge crossing the Kansas river, at Lawrence.

Family LIMNEPHILIDÆ.

Apatania pallida? Hagen. October, attracted by lamp light.

Family LEPTOCERIDÆ.

Leptocerus dilutus Hagen. July to October.
Setodes albida Wlk. July to September.
uwarowii Koll. July to September.
Mystacides punctata Banks. July to September (type, August).

Family HYDROPSYCHIDÆ.

Hydropsyche kansensis Banks. June to September.
phalerata Hagen. May to September.
scalaris Hagen. June to October; also May, at night; April; August in house, attracted by light.

ADDITIONS TO THE KANSAS LIST OF DIPTERA.

So far as determined, nearly half of the species of Diptera taken by me in Kansas are new to the state lists, the preliminary one being published by Dr. F. H. Snow, in the Kansas University Science Bulletin, volume II, No. 5, to which additions were made by Mr. F. F. Crevecœur, in Transactions of the Kansas Academy of Science, volume XX, pages 90–96. By actual count, the names of 142 different kinds of flies are herewith added to the Kansas list. In this number, two species and one variety are based on my own descriptions.

Unless especially denoted, all specimens were collected in Douglas county.

Family TIPULIDÆ.

Dicranomyia longipennis Schum. May, at night; August.
Pachyrhina ferruginea Fab. May, June, August.

Family CHIRONOMIDÆ.

Ceratopogon bipunctatus Linne. May, in window; June, twilight; August. Also in Sedgwick county; April.
pilosulus Coq. September, at electric light.
specularis Coq. May.
squamipes Coq. April, at night; May, in windows of house in early morning; May, at night; June; June, at night; July, August, September.
Ablabesmyia (Tanypus) carnea Fab., variety *b*, Joh. April.
monilis Linne. April.
nigropunctata Stgr. June; June, at night; July.
Tanypus stellatus Coq. September, at electric light.
Chironomus albipennis Meig. July, at electric light.
attenuatus? Wlk. June; July, at electric light; August.
decorus Joh. May; June; July, at electric light; September, at electric light.
flavus Joh. July, at electric light; August; September, at electric light.
frequens Joh. July and August, all at electric light.
fulviventris Joh. July, at electric light.
fulvus Joh. June, at electric light.
fumidus Joh. July, at electric light.
halteralis Coq. July, at electric light.
lineatus Say. July, at electric light.
modestus Say. June.
nigricans Joh. July, at electric light.
pallidus Joh. June, twilight; July, at electric light.
riparius Meig. March, April.
scalænus Schrk, var. June, twilight.
similis Joh. May; May, twilight; June, at night; September, in window.
stigmaterus Say. July and September, all at electric light.

Family CHIRONOMIDÆ.

Cricotopus sylvestris Fab. April.
trifiasciatus Panz. September, at electric light.
Comptocladius byssinus Schrk. April, May. Also in Sedgwick county; April.
Orthocladius nivoriundus Fitch. May.
politus Coq. July, at electric light.
Tanytarsus nigripulus Joh. March; April, at night.

Family CULICIDÆ.

Culex impiger Wlk. May, at night; July; July, twilight.
pipiens Linne. May; June; June, twilight; July, twilight; August; November.
restuans Thbld. May, May, twilight; June; June, twilight; July; July, twilight; August; August, twilight; September, in house; October.
sylvestris Thbld. April; May, at night and in house; June; June, twilight; July; July, twilight; August; October.
Tæniorhynchus perturbans Wlk. August, twilight.
Sayomia punctipennis Say. July, at electric light; August, at night.

Family MYCETOPHILIDÆ.

Ceroplatus terminalis Coq. July, September.
Mycetophila contigua Wlk. March.
discoides Say. March.

Family BIBIONIDÆ.

Bibio articulatus Say. April, May.
Dilophus serotinus Loew. October.
Scatopse atrata Say. April.
notata Linne. April, in window; May.
pygmæa Loew. April.

Family RHYPHIDÆ.

Rhyphus alternatus Say. April.
punctatus Fab. April; June; June, twilight; July, twilight.

Family STRATIOMYIDÆ.

Allognosta fuscitarsis Say. May, June, July, August.
Sargus elegans Loew. June. Also in Sedgwick county; April.

Family TABANIDÆ.

Tabanus quinquevittatus Wied. June.

Family THEREVIDÆ.

Thereva melanoneura Loew. May.

Family ASILIDÆ.

Scleropogon picticornis Loew. Sedgwick county; August.
Heteropogon phœnicurus Loew. August.
Deromyia ternata Loew. July, twilight.
Cerotainia macrocera Say. July.
Erax bastardii Macq. July.
Tolmerus annulipes Macq. New variety, delusus Tkr. June.
prairiensis Tkr. New species. Sedgwick county; August.

Family DOLICHOPODIDÆ.

Psilopodinus scobinator Loew. June, twilight.
Diaphorus spectabilis Loew. June, twilight; July, twilight; August.
Asyndetus syntermoides Wheeler. July.
Chrysotus auratus Leow. June.
longimanus Loew. July.
obliquus Loew. June, twilight; July; August.
pallipes Loew. July, twilight.
picticarnis Loew. August.
vividus Loew. May.
Sympycnus lineatus Loew. May; May, at night; June; June, twilight; July, twilight.
Dolichopus vittatus Loew. June, twilight.
Gymnopternus crassicauda Loew. June.
humilis Loew. June.

Family EMPIDIDÆ.

Drapetis latipennis Melander. June.
Syneches pusillus Loew. July, twilight.
Rhamphomyia irregularis Loew. April.

Family LONCHOPTERIDÆ.

Lonchoptera lutea Panz. May.

Family PHORIDÆ.

Phora incisuralis Loew. June, twilight.
multiseriata Ald. May.
Aphiochæta agarici Lint. May.
epeiræ Brues. May.
longifrons Brues. June, twilight.

Family PLATYPEZIDÆ.

Platypeza obscura Loew. July, twilight.
pallipes Loew. June.

Family PIPUNCULIDÆ.

Chalarus spurious Fal. June, twilight.
Pipunculus atlanticus Hough. June, twilight.
fuscus Loew. July, twilight.

Family SYRPHIDÆ.

Chrysotoxum laterale Loew., var. September.
Pipiza pisticoides Will. Sedgwick county; April.
Myiolepta nigra Loew. May, in window.
varipes Loew. May.
Ocyptamus fuscipennis Say. July.
Rhingia nasica Say. June, twilight.
Ceria willistonii Kahl. June.

Family TACHINIDÆ.

Eulasiona comstockii Twns. April.
Electops melissopodis Coq. October.
Hypostena barbata Coq. Sedgwick county; April.

Family TACHINIDÆ.

Exorista blanda O. S. June, twilight; July.
griseomicans Van der Wulp. May.
Phorocera leucaniæ Coq. July.
Acemyia dentata Coq. October.
Tachina robusta Twns. April, May.
Hilarella aristalis Coq. July.

Family DEXIIDÆ.

Melanophora roralis Linne. May, June, July, September.

Family SARCOPHAGIDÆ.

Sarcophaga (Helicobia) helicis Twns. July. Also in Sedgwick county; April.

Family ANTHOMYIDÆ.

Hyetodesia (Phaonia) mulcata? Giglio-Tos. April.
Limnophora narona Wlk. June; July; July, twilight. Also in Sedgwick county; April.
Hylemyia lipsia Wlk. April; June; July; July, twilight; August.
Forbia fusciceps Zett. April; April, at night; June; June, twilight. Also in Sedgwick county; April.
Cœnosia lata Wlk. April, July, August.
Schœnomyza dorsalis Loew. May, June.

Family HELOMYZIDÆ.

Leria pectinata Loew. April, at night.

Family BORBORIDÆ.

Limosina evanescens Tkr. New species. June; June, twilight; July, at electric light.

Family SCIOMYZIDÆ.

Sciomyza obtusa Fal. June.

Family SAPROMYZIDÆ.

Lonchæ vaginalis Fal. June.
Lauxania gracilipes Loew. July, twilight.
Sapromyza innuba? Giglio-Tos. April.
quadrilineata Loew. April.

Family ORTALIDÆ.

Tetanops integra Loew. May.
Pseudotephritis vau Say. June.
Seoptera vibrans Linne. June.

Family SEPSIDÆ.

Nemopoda minuta Wied. June, twilight; July; July, twilight.

Family PSILIDÆ.

Chyliza apicalis Loew. June, twilight.

Family EPHYDRIDÆ.

Hyadina albovenosa Coq. April, at night.

Family OSCINIDÆ.

Chlorops palpalis Adams. May, twilight.
Hippelates flavipes Loew. June. Also in Sedgwick county; April.
pusio Loew. June, twilight; August. Also in Sedgwick county; April.
Oscinis carbonaria Loew. April, at night; May, at night.
coxendix Fitch. April; June, twilight. Also in Sedgwick county; April.
decipiens Loew. July.
soror Macq. May, June.

Famils DROSOPHILIDÆ.

Drosophila (Scaptomyza) adusta Loew. May, at night; August.
amœna Loew. April.
funebris Fab. May; June; July; July, twilight; October; and November, in kitchen.
(Scaptomyza) graminum Fal. April; April, at night.

Family AGROMYZIDÆ.

Phytomyza diminuta Loew. May; June, twilight and at night.
Ceratomyza dorsalis Loew. May, at electric light; June.
Agromyza æneiventris Fal. July.
parvicornis Loew. Sedgwick county; April.
Desmometopa latipes Meig. June.
m-nigrum Zett. June.
Ophthalmomyia lacteipennis Loew. Sedgwick county; August, in windows of farmhouse.

NOTICE OF NEW ELEMENTS IN UINTACRINUS.

By H. T. Martin, University of Kansas, Lawrence.

THE present notice is to call attention to some new structures discovered on a small portion of a weathered crinoidal slab in the writer's collection, supplemented by several specimens belonging to the University collection.

The feature that is of particular interest is the course of the axial nerve system inside the cup and extending as far as the second secundibrachs.

The discovery was made too late for a paper to be read before the Academy. Consequently, a full description, now in preparation, with accompanying plates, will appear in the next *Kansas University Science Bullletin.*

SOILS AND BACTERIA.*

By LYMAN C. WOOSTER, Ph. D., State Normal School, Emporia.

OWING to the inexact forms of statement used by many writers, most people believe that plants use as foods certain minerals found in soils, while animals eat organic materials found in plants and other animals. Any one who knows aught of the needs of plants and animals and of the nature of foods knows that plants and animals must both have for their tissues and activities starch, sugar, oils, and proteids; and that no plant, except a few bacteria, can get energy and tissue foods directly from the mineral world. Water, carbon dioxid, potassium and sodium nitrates, ammonia in some form, sodium chlorid, calcium sulfate (gypsum), magnesium sulfate (epsom salts), calcium phosphate and some soluble compound of iron are merely the crude materials out of which green plants, in the presence of sunlight or the light of the electric arc, build their foods, such as starch, oil, and the proteids. The minerals named above are crude food materials, and are foods in no other sense; but their presence in soils is as necessary to complex plants as are brick, mortar and lumber to the house-builder.

The amount of these crude food materials used by a crop of wheat, for example, is surprisingly large. From a single farm of 160 acres, where exclusive wheat farming is followed, there is an annual waste of fertility equivalent to 28,500 pounds of nitrogen, 5000 pounds of potash, 3000 pounds of phosphoric acid, and 1600 pounds of lime. Unless these minerals are returned to the soil, the land must continue to diminish in productiveness till it finally becomes barren. This was the fate of the old tobacco plantations of old Virginia, and is soon, certainly within fifty years, to be the result of continuous wheat cropping in Kansas without the use of fertilizers.

The humus and bacteria of the soil are most directly concerned with its nitrogen content, and it is to these elements of fertility that I wish to address myself.

It is very unfortunate for the farmer that no cultivated plant can use uncombined nitrogen as a crude food material, for the atmosphere is four-fifths nitrogen. The nitrogen used by plants

* In preparing this paper I have freely used the observations and experiments described in two standard works, "Bacteria," by Geo. Newman, published by G. P. Putnam's Sons, and "Physics of Agriculture," by F. H. King, published by author, Madison, Wis., together with my own personal observations and experiences. These have served as the bases of the inductions, which I trust will be of some service to the farmers of our state.—L. C. W.

large enough to be seen by the unaided eye must be in the form of a nitrate, such as Chili saltpeter or common saltpeter, or possibly in some salt of ammonia.

Could cultivated plants use atmospheric nitrogen directly, the chief problem of soil fertility would be solved. More than 33,000 tons of nitrogen rests on each acre of ground. Contained in Chili saltpeter, this amount of nitrogen would be worth $4,000,000 per acre, and the supply would be inexhaustible. So far as is now known, bacteria alone, of all plants, can use nitrogen and the nitrites as crude mineral foods. Fortunately they excrete the substances as nitrates. The higher plants then absorb the nitrates and the other mineral food materials and prepare the various proteids to increase their cell protoplasm.

Soil bacteria are of many kinds; and the number of individuals of each kind, even in a handful of soil, is almost beyond comprehension. One gram (one-fourth teaspoonful) of virgin soil contains 53,436 bacteria; and the same amount of soil from a cemetery supports 363,411 bacteria. Few are found below a depth of six feet. Their rate of increase in numbers through cell division is equally remarkable. Milk fresh from the cow contains on the average 15,000 bacteria to the cubic centimeter (one-fourth teaspoonful); milk four hours old has in the same volume 100,000 bacteria, fifteen hours old, 6,000,000, and ten days old, 1,000,000,000 of these remarkable plants.

Though the systematic study of bacteria is less than a half a century old, and though each species varies in form and activity through wide limits, in a few hours, in different environments, 600 or 700 kinds have been named and described. These kinds may be grouped, for the purposes of this paper, in five or six classes:

1. The bacteria of putrefaction.
2. The air-hating, denitrifying bacteria.
3. The air-loving, nitrifying becteria.
4. The nitrogen-fixing, root-tubercle bacteria.
5. The pathogenic bacterta.

1. The bacteria of putrefaction reduce the bodies of plants and animals to the condition called humus in soils. The complex organic compounds are broken down, resulting in a release of energy and much cell-substance material for the bacteria and in the evolution of various gases, such as carbon dioxid, dihydric sulfid, ammonia, and probably some nitrogen. However, the work of these bacteria seems to be necessary in order that organic matter

may be reduced to a usable condition. Among these bacteria are: *Bacillius colli*, *B. mycoides*, *B. mesentericus*, *B. liquidus*, *B. prodigiosus*, *B. ramosus*, *B. vermicularis*, *B. liquefaciens* and many members of the great family of *Proteus*.

2. The air-hating, denitrifying bacteria are responsible for the more or less complete destruction of the nitrates in the farm and commercial fertilizers, when these are buried in such a way that air is largely excluded. They also do an important work in assisting the bacteria of putrefaction in destroying excrement in cesspools and retention vats, where sewage is detained for work of this character. These bacteria work best where the supply of air is limited and the amount of organic matter great. The organic matter is oxidized with oxygen taken from the nitrates, and a distinct rise of temperature results, as may be seen in heaps of manure. Much nitrogen, consequently, is lost to the manure and soil. Among the denitrifying bacteria that have been isolated are: *Bacillus fluorescens non-liquefaciens*, *Mycoderma ureæ*, and some of the *Staphylococci*.

The very effective character of the work done by the putrefactive and denitrifying bacteria was proved by the late Colonel Waring, the eminent sanitary engineer. He kept two tons of dry earth for use over and over in dry-earth closets. The closets were emptied once in two months in heaps on the floor of a dry cellar. This material was used, in all, about ten times, and then the material was analyzed for the amount of nitrogen it contained. It was found that 4000 pounds of the soil had only eleven pounds of nitrogen, though at least 230 pounds had been added to it and it contained three pounds at first.

It would seem, then, from this and other experiments, that farm manure would better be spread in layers, in the barn-yard, a few inches thick, till it is somewhat decomposed, and then spread thinly over the fields and not plowed in deeply, unless the surface can be frequently cultivated, so the air can have free access to every portion of the soil containing the fertilizer. In this way the air-hating bacteria will be deterred from working in the fertilizer overmuch.

3. The work of the air-loving, nitrifying bacteria beautifully complements that of the denitrifying bacteria, if they are given a fair chance. As their name implies, they work best in loose soil near the surface of the ground, and are nearly absent from soil at a greater depth than two feet. They are of several kinds, and are very numerous in rich, porous humus. Some change ammonia to nitrites, and others change nitrites to nitrates. They do not work

in acid soils, nor in soils strongly alkaline, but do best in soils faintly alkaline. Acid soils must be neutralized by alkaline earths, such as quicklime and wood ashes; alkali spots should be sanded and drained, or crude sulfuric and nitric acids may be sprinkled over such places.

The air-loving, nitrifying bacteria work on the surface of sewage in the retention vats, and very vigorously when it has been passed out into small, open fields, where the sewage may stand a few days, spread out in a stream a few inches thick. The bacteria reduce organic matter unreduced and oxidize the ammonia, nitrites, and sulfites. When this work has been completed, the sewage is ready to be used as a fertilizer.

The nitrifying bacteria use various organic matters (of which phosphates are essential constituents) as foods, though the remarkable fact has been discovered that the nitrifying organisms can develop and perform all their functions on inorganic materials. They have the power to live and grow in a medium consisting solely of acid carbonates of sodium and calcium in an ammoniacal solution undergoing nitrification. No other plants destitute of chlorophyll can do this.

The nitrous bacteria have been named *Nitrosomonas* and *Nitrococcus*, and the nitric organism the *Nitrobacter*. These are evidently most valuable to all farm crops, as without them the soil would soon become barren.

4. The root-tubercle bacteria are recent discoveries. For a long time it has been known that the clovers, peas, beans and other legumes not only do not exhaust the soil, but even leave it in better condition than before the crop was grown. Certain tubercles on the roots of these plants are crowded with bacteria which are now known to possess the power to use the free nitrogen and oxygen of the air in preparing those compounds of nitrogen that serve as crude food materials to the host-plants. The mutual relation existing between the legume and the bacteria is not well understood, but there is no question as to the benefit accruing to the host.

Certain companies are now preparing cultures of bacteria, appropriate for use on the several crops of legumes, to sell to farmers and gardeners. The Western Nitrogen Culture Company, of Topeka, prepares packets of bacteria and food, to be used on sixteen important legumes, one packet for each kind. The tubercle bacteria do not thrive in acid or strongly alkaline soils, but in average Kansas soil they multiply rapidly, and their excretions in the tubercles cause a greatly increased growth of the legume and at

the same time help to enrich the soil. These bacteria, beyond question, increase the growth of alfalfa and Red clover. Indeed, it is largely because of their presence in the soil that these crops continue to flourish in Kansas.

The root-tubercle bacteria are air lovers, and the soil must be kept loose by cultivation or kept well shaded by the crop when wet, or alfalfa, clover and the other legumes will not make their best crop. Dressings of land plaster (gypsum) help these plants wonderfully, but a porous soil is of the first importance.

In the best soils the pore space equals one-half the volume of the soil. In clay soils it is more; in sandy soils, strangely enough, it is less. As pore space is either air space or water space, the importance of thorough water drainage, both surface and subsoil, is evident. When the pore space is filled with air, the air-loving, nitrifying bacteria and the root-tubercle bacteria flourish best and the heaviest crops are harvested. When the pore space is largely reduced by plowing when the soil is too wet, or is filled with flood-water, the air-hating, denitrifying bacteria rob the soil of its nitrates, and light crops are harvested. Puddled soil may be excellent for dirt roads—indeed, makes the best roads when quickly dried, with the pore space absent or largely reduced—but, on the farm, it cannot grow valuable crops.

5. Pathogenic bacteria are frequently found in rich soils. Among the most numerous and dangerous of these is the bacillus of tetanus (lockjaw). No wound received in stables is a safe wound. The bacillus works in the wound; and lockjaw is caused by its excretions, which are absorbed by the blood and carried to the nerve centers.

The bacteria which cause typhoid fever and tuberculosis are likewise found in rich soils. The germs of typhoid fever may live in soil impregnated with the excretions of a typhoid patient 456 days, and the germs of tuberculosis are found to be alive in soil several weeks after having been added to it. All germs of this character should certainly be destroyed before they are thrown upon soil.

Other disease germs are known to exist in the soil, some of bacteria and others of animals—the protozoa. It is probable that some of the latter get into the drinking water and cause dysentery and, possibly, appendicitis.

The soils about buildings are being studied with the greatest care, and, while very much remains for future work, enough is now known to make it certain that water from deep wells, wells with

cemented walls and situated on highest ground near house, or else boiled water, is the only water safe to drink, if one would escape these deadly diseases.

All that has been given in this paper is in full accord with the rules established empirically by our most successful farmers. The use of fertilizers, the thorough cultivation of the soil and the rotation of crops are the A-B-C's of profitable farming. The one supplies the plants with necessary mineral food elements, the next aerates the soil for the air-loving, nitrifying bacteria, and the last gives time for the rise from the subsoil of the mineral food elements peculiar to each crop.

Any of these three things can be overdone, especially the second and third. Plowing in deeply much coarse material so opens up the soil that the water to a depth hurtful to the crop is wasted. On the other hand, thin surface cultivation, producing a soil mulch, is very beneficial in dry seasons, as the amount of soil thoroughly dried is small, and this thin layer of loose earth stops the water that is rising from the greater depths through capillary tubes. Taking as a standard soil not cultivated, the water saved by a cultivation one inch deep, once a week, was nearly 25 per cent., twice a week, was over 27 per cent.; three inches deep, was 27 per cent. and 32 per cent. for once and twice a week respectively.

Crop rotation is found to be much better for soil bacteria of the helpful kinds than absolute rest. The latter, where there is no cultivation, enables the air-hating, denitrifying bacteria to destroy more fertilizers than the rest brings in from rock, gravel and subsoil disintegration.

ADDITIONS TO THE LIST OF KANSAS BIRDS.

By F. H. Snow, University of Kansas, Lawrence.

IN the spring of 1905, from April 27 to May 9, Mr. Edward R. Warren collected birds and mammals at Monon, in Baca county, Colorado, which lies immediately west of Stanton county, Kansas. An annotated list of these birds was published by Mr. Warren in *The Condor* of January, 1906. Monon is a post-office station which appears on the official railroad map of Kansas of 1901, about one-half mile east of the Colorado line. For some reason Mr. Johnston, the postmaster, moved his residence just across the state line and took the post-office with him; so that Monon, formerly on the western edge of Kansas, is now on the eastern edge of Colorado, hardly half a mile from the state line.

Among the birds taken by Mr. Warren were eight species not up to this time recorded as Kansas species but which seem to me to be properly entitled to a place on the Kansas list. Some of these species were taken in a small grove of cottonwood trees, the western portion of which lies in Colorado and the eastern portion in Kansas.

The remarks within the quotation marks in the following list are from Mr. Warren's article in *The Condor:*

The eight species which I consider entitled to a place in the Kansas avifauna are as follows:

I. The Scaled Partridge (*Callipepla squamator* Vig.) Previously recorded from north to central and western Texas, New Mexico, and southern Arizona. (See the A. O. U. Check-list of North American Birds.) "This species has made its appearance at Monon within the last fourteen years. They are gradually working their way into Kansas. Professor Cooke, in his Second Appendix to the Birds of Colorado, speaks of what he calls a queer state of affairs regarding the occurrence of this species in Colorado, and notes that at first it was supposed to be very rare, and then it was found to be common in the cedars, and at the time of the publication of this appendix the birds had found their way to the Arkansas river at Rocky Ford. My observations show that they are common in the cedars, and that they are still working east."

II. The Spurred Towhee (*Pipilo maculatus megalonyx* Baird). Previously recorded from the Rocky Mountain region of

the United States to California. "Although towhees were not uncommon at that time at Monon, two specimens were unfortunately the only ones collected."

III. THE GREEN-TAILED TOWHEE (*Pipilo chlorurus* Towns.) Recorded as occupying the interior plateau region of the United States. "First seen at Monon May 3, when there were many in the cottonwoods along Bear creek."

IV. SWAINSON'S VIREO (*Vireo gilvus swainsoni*). "One specimen taken May 3 at Monon, and another at Springfield May 30, both in the trees along Bear creek."

V. VIRGINIA'S WARBLER (*Helminthophila virginiæ*). Recorded from the Rocky Mountain region of the United States. "A single specimen, a male, taken May 3, at Monon, which extends its range very much to the east."

VI. MACGILLIVRAY'S WARBLER (*Geothlypis macgillivrayi* Aud.) This species was taken at Springfield, twenty-five miles west of the state line. It is a migratory bird, has been taken at Gainesville, Tex., and in western Nebraska, and must pass through Kansas in the migrating seasons. "Seen only near Springfield, as usual among the trees along Bear creek. First seen May 11; several seen the next few days. The last one seen was a male of the preceding year in immature plumage, taken May 30."

VII. THE SAGE THRASHER (*Oroscoptes montanus* Towns.) This species was taken at Springfield. It has also been taken in western Nebraska and without doubt is a Kansas bird.

VIII. THE DWARF HERMIT THRUSH (*Hylocichla aonalaschkæ* Gmel.) Previously recorded as occurring in the Pacific Coast region from Alaska to Lower California and western Mexico, east, during migrations, to Nevada and Arizona. "First seen May 1, at Monon, where one was shot in a tree beside Bear creek. On May 11, at Springfield, they seemed common among the trees along Bear creek. Disappeared a day or two after."

A very interesting capture during the present year was a specimen of the Chaparral cock or Road-runner (*Geococyx californianus* Less.), at Emporia, Kan. This capture was made by the children of Mr. David Taylor, of Emporia, by whom it was kept alive as a pet. This information was received from Prof. L. C. Wooster, of the State Normal School, on June 3.

NOTES ON THE KANSAS BIRD LIST.

By D. E. LANTZ, Washington, D. C.

NORTH AMERICAN ornitholgy has made considerable advancement in recent years, but Kansas observers have not kept up with the general progress. In spite of the recent publication in the Transactions of the Academy of Science of two lists of the birds of the state, we have at present no state list that properly represents the actual bird fauna of Kansas.

The geographical position of Kansas makes its fauna of peculiar interest. It contains the division between two life zones—the Upper and Lower Austral; and since its western part is in the semiarid plains, we have representatives of four faunal areas within her borders. The Alleghanian fauna is the most important, being dominant over approximately the eastern two-thirds of the state, except an irregular strip on the south, which belongs to the Carolinian. The western third of the state is principally Upper Sonoran, but in the portion from the Arkansas valley southward the Lower Sonoran forms are dominant. However, these faunal areas are not well defined for the various species of birds, and the distribution of many of them in Kansas is practically unknown. Many common Eastern birds are replaced in the West by well-marked races, or subspecies, which belong to the plains or plateau faunas. In many of these cases Kansas has representatives of both forms, one not hitherto reported; in others, of but one, with the wrong form now credited to the state. Besides, the Southern fauna—the Lower Austral forms that come into the state—have surely not all been reported. In these respects our Kansas bird list is far from being perfect.

In regard to nomenclature, our list has not been kept "up to date." When, in 1897, I presented to the Academy a "Review of Kansas Ornithology," the attempt was to show the historical side of the work already done by observers in the state. Unfortunately I overlooked the eighth supplement to the A. O. U. Check-list, and the list I then published contained eleven bird names that had become obsolete. When, four years later, Doctor Snow's "Catalogue of Kansas Birds" was published, two additional supplements to the A. O. U. list had appeared, but the nomenclature of the "Twentieth Century Catalogue" contained none of the changes made by the A. O. U. committee in either the eighth, ninth or tenth supplements.

Since then three more supplements have appeared, and the Kansas list has now many more obsolete names.

In the past ten years many new facts of bird distribution have been discovered. The study of the Texas fauna by the United States Biological Survey, as well as the careful work done by ornithologists in Colorado and Nebraska, has shown how little is actually known of Kansas birds. Kansas ornithologists have many problems left for solution before an absolutely correct list of our birds can be prepared. An examination of the references in the first three volumes of Robert Ridgway's monumental work, "The Birds of North and Middle America," has shown some of these deficiencies, a few of which I will mention.

Do both forms of the Evening grosbeak occur in Kansas, or only the Western?

Have we the Red crossbill or only the form listed of *Loxia curviostra stricklandi*, but which is really *L. c. bendieri?*

Does the Western goldfinch belong to the fauna of our western counties? It has been taken in summer in Nebraska.

How far east in Kansas does the Western lark sparrow (*Chondestes grammacus strigatus*) range?

Both forms of the Vesper sparrow occur. How far west does *Poœcetes gramineus* range before being replaced by *confinis*, which occurs over the greater part of western Kansas?

The Alaskan longspur may occur in western Kansas in winter. No records of its capture have been made. The Western form (*bimaculatus*) is our most common Grasshopper sparrow. Do we have also the Eastern form, now credited to the state? This will probably be determined in the affirmative.

Baird's sparrow should be abundant in migration over a large part of western Kansas. There are no records of its capture.

Do we have the Western form of Henslow's sparrow? It has been found breeding in Nebraska.

How many forms of *Junco* enter the state? *Junco oregonus* (or *oreganus*) does *not* occur. Our birds are *shufeldti* or *montanus*, probably both. *Junco caniceps* may also occur in the western part. *Junco hyemalis* is the common bird of the state.

How far east does the Western Tree sparrow range? We should have the Western Field sparrow and possibly the Western Chipping sparrow.

Brewer's sparrow may breed in northwestern Kansas. It has not been reported in the state.

The Green-tailed towhee may possibly be found in the canyons of western Kansas.

Our common Blue grosbeak in central Kansas is the Western form, *lazula*. The Eastern form, now on the list, may also occur in eastern Kansas.

Here are a score of questions relating to our sparrows which have not been settled. Other groups present similar unsettled problems. For instance, how many forms of the Red-winged blackbird occur in the state? It is certain that the large-billed form (*fortis*) should be added to the state list. The Migrant shrike (*Lanius ludovicianus migrans*) should probably be substituted for the Loggerhead shrike. Our Long-billed marsh wren is the prairie form *iliachus*. Baird's wren does not occur north of Mexico. The Kansas Bewick wren is probably *Thryomanes bewicki cryptus* for the greater part of the state. Typical *bewickii* may occur in eastern Kansas. Only one form of mocking-bird appears on the list. The White-winged form is certainly present in western Kansas. Possibly two forms of Traill flycatcher occur.

The present would be an inopportune time to attempt a revision of the state list. The nomenclature committee of the American Ornithologists' Union are at work upon a new check-list of North American birds. A rearrangement of families is expected, as well as radical changes in the names of birds. A state list prepared in advance of the publication of the conclusions of the American Ornithologists' Union committee would be almost worthless.

In the meantime a study of the birds of the state for the purpose of determining the actual distribution of Eastern and Western forms is all important. Specimens in breeding plumage as well as winter birds should be collected. Especially is it worth while to study the birds of southeast and southwest Kansas, to determine the Carolinian and Lower Sonoran forms that enter the state. While but little is known of the birds that breed in the extreme northwest and southwest parts of the state, a winter study of the birds of those sections would also yield unreported forms.

In addition to field-work, it is desirable that the various public and private collections of bird skins in the state should be submitted to competent authority for comparison with types and properly determined specimens. This can be done only in the larger museums, and probably best in the United States National Museum, in Washington.

Should these suggestions be carried out, I have no doubt that the Kansas bird list will be considerably increased, and the total of forms approach very nearly to the 394 and 400 accredited, respectively, to Colorado and Nebraska.

ADDITIONS AND CORRECTIONS TO THE LIST OF KANSAS MAMMALS.

By D. E. LANTZ, Washington, D. C.

SINCE the publication, two years ago, of my list of Kansas mammals, further work in the field, together with comparisons of material in the collections at Washington, have made it possible to correct some errors of the former paper and to add several species to the state list.

I.—ADDITIONS.

1. Citellus tridecemlineatus texensis (Merriam). Texas Spermophile.
   This red variety of the Striped prairie squirrel was taken by me last year at several Oklahoma places and at Medicine Lodge, Kan. I find also that Vernon Bailey had taken specimens of this subspecies at Kiowa, Kan., in 1892.
2. Peromyscus leucopus (Rafin.) White-footed Deer Mouse.
   This woodland form of the White-footed mouse was found abundant at Manhattan last year. The collections of the United States National Museum and the Biological Survey contain specimens from Leavenworth, Onaga, Fort Riley, and Neosho Falls.
3. Peromyscus luteus (Osgood). Buff Deer Mouse.
   Taken by me in 1905 at Medicine Lodge and Hays City, and by J. Alden Loring, previously, at Pendennis. The Hays City specimens are intermediates between *P. luteus* and *P. michiganensis*, with some individuals approaching very nearly to typical *luteus*.
4. Peromyscus attwateri Allen. Attwater Deer Mouse.
   Four specimens taken in 1892, by Vernon Bailey, at Cedar Vale, Kan., and now in the Biological Survey collection, belong to this Southern form, which has also been found at Dougherty, I. T., by Thaddeus Surber, of the Field Museum.
5. Reithrodontomys griseus Bailey. Little Gray Harvest Mouse.
   This Harvest mouse was recently described from Texas (Bailey, N. A. Fauna, No. 25, p. 106, 1905). Specimens in the Biological Survey collection from Onaga, Pendennis and Wa Keeney have been referred to the new form. It seems to occur at the three Kansas points named, associated with *R. dychei* but is not so abundant as that species. It differs from *dychei* in smaller size, grayer color, and shorter skull.
6. Neotoma micropus Baird. Small-footed Wood Rat.
   Wood rats in the Kansas State Agricultural College museum, secured at Sun, Barber county, prove to be of this species. This rat had been previously taken in Woodward, Woods and Beaver counties, Oklahoma, and is probably common in the gypsum hills of southern Kansas.

7. Geomys breviceps llanensis Bailey. Mesquite Plains Gopher.

This pocket-gopher was described last year by Bailey (N. A. Fauna, No. 25, p. 129, 1905). It was taken by me at Medicine Lodge, Kan., and to it are to be referred nearly all the specimens from southern Kansas which have hitherto been regarded as intermediates between the three forms, *G. breviceps*, *G. bursarius*, and *G. luteus*.

8. Corynorhinus macrotis pallescens Miller. Pallid Big-eared Bat.

Bats with long ears have frequently been reported from the gypsum caves in Oklahoma and southern Kansas, but specimens were not available to determine the species. I heard of them last year (1905) at Alva and Medicine Lodge. Later, collectors from the State Agricultural College secured a specimen at Sun. This I have not seen; but a specimen from Alva, Okla., was sent me last spring by Prof. G. W. Stevens, of the Northwestern Normal School, and was identified by Mr. Gerrit S. Miller, jr., as the Pallid Big-eared bat. I have no doubt that this is the only form of the genus that occurs in Kansas. The bat is quite rare, there being but a few scattered records of its occurrence. It has been taken once in Texas, once in the Black Hills, South Dakota, and once in Larimer county, Colorado. These are the only previous records east of the Rocky Mountains.

II.—ELIMINATIONS FROM THE LIST.

1. Peromyscus texanus (Woodhouse).

This was reported from Pendennis, but is undoubtedly *P. luteus* and not the Texas species.

2. Peromyscus texanus nebrascensis Mearns.

While it is possible that this mouse occurs in the extreme western part of Kansas, its presence has not been proved by actual captures.

These two eliminations leave four species of *Peromyscus* actually known to occur in the state—*P. michiganensis*, on open grounds and in cultivated fields in the eastern half of the state; *P. luteus*, the bleached form, which replaces *michiganensis* in the western part of the state; *P. leucopus*, found in the woods of eastern Kansas; and *P. attwateri*, representing the extension of the Lower Sonoran fauna into southern Kansas.

3. Neotoma campestris Allen.

Not separable from *Neotoma baileyi*, which has priority of publication. Specimens from western Kansas (the type of *N. campestris* was collected at Pendennis) are slightly paler than those from the eastern part of the state, but there are no other characters to separate them.

4. Geomys breviceps Baird.

The Fort Riley specimens collected by Doctor Hammond do not seem to be extant, and at present there is no proof of the occurrence of typical *breviceps* in the state.

The foregoing additions and eliminations leave the number of mammals now credited to Kansas as eighty-five.

III.—REMARKS.

Didelphis californica: In my former list* I fell into the error of stating that *D. californicus* [= *D. marsupialis*] may possibly belong to our fauna. Elliott's statement in his Synopsis of North American Mammals, that this species occurs in Oklahoma, together with the occurrence of dark colored opossums in southern Kansas, led me into the error. There is no probability that it will ever be taken either in Kansas or Oklahoma. The dark phase of *D. virginiana* is common throughout the state.

Oryzomys palustris Harlan: An examination of the specimen of Rice-field mouse sent to the National Museum by Capt. B. F. Goss shows that it is of this species, known at present only from the Gulf Coast region. Whether these animals once occurred in Kansas or whether there was an error as to the locality from which the Goss specimens came will probably never be known.

Bassariscus astutus: Professor Knox included the Northern civet cat in his list of Kansas mammals on the authority of Dr. J. A. Allen. Doctor Allen informs me that his information was all second-hand, and not based upon the capture of specimens. Settlers seemed to be familiar with the animal, and Doctor Allen was reasonably sure that the animal occurred in the western part of the state.

Lynx baileyi Merriam (Plateau lynx): The Spotted lynx of southwestern Kansas and western Oklahoma is quite probably of this species. A specimen was secured in Barber county by collectors for the State Agricultural College, but it has not been compared with others that have been identified.

Vulpes fulva macroura (Baird): In *Forest and Stream* (vol. 27, p. 465, January 6, 1887), I find this record, signed N. S. Goss, Topeka, December 27, 1886: "A little over a year ago Mr. Fred Whitney killed a Prairie fox (*Vulpes macrorus* Baird) in Cowley county. He had the animal mounted, and it is now at his home in Meade county. It is the light colored variety spoken of by Professor Baird in his work on mammals (P. R. R. Rept., vol. 8, p. 130), and the first, to my knowledge, captured in the state. Mr. Whitney says that another one has since been killed in the same vicinity." It would be interesting to know whether this specimen owned by Mr. Whitney is still in existence.

Nyctinomus: A specimen of Free-tailed bat was collected at Manhattan by Dr. C. P. Blachly, and sent to Professor Cragin, of

* Trans. Kan. Acad. Sci., vol. XIX, pp. 171-178, 1905.

Washburn, in 1884. Professor Cragin refers to it under the name *Nyctinomus nasutus.* The specimen is probably *Nyctinomus mexicanus*, which occurs over much of Texas. A proper determination of the specimen, which probably remains in the Washburn College museum, will add another species to the Kansas list of mammals.

IS THE GILA MONSTER A POISONOUS REPTILE?

By F. H. Snow, University of Kansas, Lawrence.

IN the desert regions of southern Arizona, southern California, and Sonora, Mexico, a common reptile is the so-called Gila monster, the *Heloderma suspectum* of Cope. Three summers spent in the work of the University of Kansas collecting expeditions to southern Arizona have brought the writer of this paper into somewhat familiar relations with this creature, in regard to whose real character there has been so great a diversity of opinion among non-residents of its natural habitat. In 1886 I had a healthy specimen of the monster sent to me from Arizona by a former student. This specimen I kept in confinement at the University for three years, during which time it subsisted upon a diet of raw eggs. In order to determine whether it was venomous or not I allowed it to bite young kittens, which exhibited no symptoms of having been poisoned, the only effect of the bite being a slight swelling due to the mechanical pressure exerted by the prolonged closing of the powerful jaws of the reptile upon the part attacked.

During the past summer, on July 26, 1906, I had the fortune to be bitten on the ball of the right thumb by a Gila monster, one of a pair which had been captured some two weeks previously and kept in a large box awaiting our departure from camp upon our homeward journey. In the same box were also placed two specimens of a very large frog. Late one afternoon it was observed that one of the frogs had been bitten by one of the Gila monsters. The next morning the bitten frog was dead and its body had shrunken to half its former dimensions. This was the first indication I had observed suggesting that the *Heloderma* might be venomous.

When we broke camp the two Gila monsters were placed in a galvanized-iron water-bucket, over the top of which a towel was tied to prevent the escape of the reptiles. I sat upon the seat with the driver with this bucket in front of me between my feet. The motion of the wagon apparently disturbing the serenity of the reptiles, they soon began to attempt an escape by pushing their heads against the towel. Being fearful that they would accomplish their purpose, whenever the prominence caused by the upward pressure indicated the location of the head of one of the monsters, I would force it down by a rap with the handle of the driver's whip,

or with my spectacle case. At last, becoming a little careless, I used my hand instead of the artificial tools. In one of these careless movements I was struck in the ball of the right thumb by one of the indignant reptiles, receiving six incisions, four of which were of considerable depth, from which the blood flowed in considerable quantities. Fortunately the jaws did not close upon the thumb so that there was no crushing effect produced. I sucked the blood from the wounds until one of my associates, Mr. L. A. Adams, who had some years ago suffered severely from a rattlesnake bite, provided me with a vial of permanganate of potash, which was kept in contact with the wounds for about an hour. No evidence whatever of poisonous effect from this bite was to be detected, and I began to doubt the venomous character of the reptiles, since, notwithstanding the prompt application of the proper remedies, it seemed inevitable that at least some faint trace of the poison should have been left. But unless the Gila monster were in fact a venomous reptile, how could its universal bad reputation be accounted for? I think I may say that, without a single exception, the residents of Arizona and Sonora believe the bite of the *Heloderma* to be a very a dangerous infliction, and several instances were circumstantially related to me of ranchmen and cowboys who had suffered untold agonies and had narrowly escaped death after one of its vicious attacks.

Since my return from the expedition which gave me this unusual experience I have been looking up the literature of the subject, and have had correspondence with some high authorities. Dr. S. Weir Mitchell, of Philadelphia, writes as follows: "This beast bites and lets go, and there is no result. The poison acts when it *chews* on the animal it bites." An article by Doctor Mitchell and Dr. Edward T. Reichert in the *Medical News* (vol. XLII, p. 209) gives the results of careful experiments by injecting the saliva of the Gila monster into pigeons, rabbits, and frogs. The following conclusions are reached:

"That the poison of *Heloderma* causes no local injury. That it arrests the heart in diastole and that the organ afterwards contracts slowly—possibly in rapid *vigor mortis*.

"That the cardiac muscle loses its irritability to stimulate at the time it ceases to beat.

"That the other muscles and the nerves respond readily to irritants.

"That the spinal cord has its power annihilated abruptly and refuses to respond to the most powerful electrical currents."

This article goes on to state that "there remains in our minds no doubt as to the fact that the saliva which drops from the mouth of *Heloderma* when it bites is a very active poison. The briefest examination of the lizard's anatomy shows why it has been with reason suspected to be poisonous and why it poisons with so much difficulty. Unless the teeth are entire, the poison abundant, and the teeth buried in the bitten flesh so as to force it down into contact with the ducts, where they open at the crown of the teeth, it is hard to see how even a drop of the poison could be forced into the wounds. Yet it is certain that small animals may die from the bite, and this may be due to the extraordinary activity of the poison and to the lizard's habit of tenaciously holding fast to what it bites, so as to allow time for a certain amount of absorption."

The latest contribution to the literature of the subject is from the pen of George Wharton James, of Pasadena, Cal., who writes as follows: "Many people will tell you that the *Heloderma* has no poison glands, and that therefore its bite cannot be dangerous. This is a most dangerous illusion. The venom of the *Heloderma* is as poisonous as that of the rattlesnake, as several people who have been bitten have found out to their cost. For many years I have been investigating this subject, and I will make quite clear why some people are bitten by the *Heloderma* without injury and others suffer severely. The venom-glands are situated under the chin, thus being on the lower jaw instead of the upper, as in the case of the rattlesnake. They are modified from glands which correspond to the sublingual glands of mammals. There are four ducts leading out of each gland. These ducts perforate the lower jaw and open in front of the grooved teeth.

"A careful study of the dentition of the *Heloderma* shows that there are several intermediate forms between the unmodified teeth of the reptile and the fully developed poison-fangs. The poison-glands are compound tubular glands, closely resembling the other salivary glands in structure. The peculiarity of their secretion is to be explained by their physiological activity rather than by their structure. So writes my friend, Dr. C. A. Whiting, of the Pacific College of Osteopathy, who has given some time to the study of the teeth and glands of the *Heloderma*. Though their poison teeth are grooved, there is no connection between the poison-glands and the teeth, as in the case of the duct of the rattlesnake. The poison pours out onto the floor of the mouth, between the lips and the gums; that is, into the interior of the bottom jaw. Being below the teeth and not directly communicated to them, the poison

sometimes fails to find its way into a wound. The saliva of the upper jaw is perfectly harmless, as is also the same saliva in the lower jaw; but it must not be forgotten that there is also a deadly venom in the lower jaw, which gets mixed with the saliva.

"As a rule, the Gila monster is lazy and sluggish, and one might play with him for hours and keep him as a pet for years and never see any sign of anger; but let him be angered and then he is dangerous, and the real danger comes when, as he bites, he turns over. With a vicious lunge he seizes the object and at the same moment turns over with lightning-like rapidity. He can hold on with the tenacity of a bulldog, or he can bite so quickly that he snips a piece of flesh out easier than one would pinch off a piece of a cracker. I have seen this action a hundred times, and this is what one must beware of. When the reptile thus bites, holds on, and turns over, the danger of the case is as great as the most dangerons bite of a rattlesnake, for, in this position, if the poison-glands are active, the saliva and poison commingle and flow freely into the teeth, and thus into the wound."

NOTES ON THE BIRDS OF THE BABOQUIVARI MOUNTAINS

During the Months of June and July.

By L. A. ADAMS, University of Kansas, Lawrence.

WHILE on an entomological collecting trip with Doctor Snow last summer, through his kindness I was permitted to make a collection of bird skins from this locality.

The Baboquivari range is located sixty miles south of Tucson, Ariz. It is about forty miles long and ten miles wide, and extends in a southwesterly direction, the highest point being Baboquivari Peak. It is 10,000 feet above sea-level. The rest of the range is low, and has an elevation of about 5000 feet.

We were camped in a canyon which fairly teemed with insect life. The canyon was well covered with vegetation, and many flowering trees and shrubs, although water was very scarce.

RAPTORES.

1. Aquila chrysætos. Golden Eagle.
   Several eagles were seen soaring above the canyon, and near the summit of the range.
2. Buteo albicaudatus. Sennett's White-tailed Buzzard.
   This buzzard was seen frequently on the lower part of the range.
3. Buteo abbreviatus. Zone-tailed Hawk.
   Rather common at the mouth of the canyon. A Mexican vaquero brought one to me alive. In crossing the desert early in the morning he had seen the hawk sleeping on a mesquit tree and had caught him alive.
4. Accipiter cooperi. Cooper's Hawk.
   Frequently seen in the canyons. One nest was found, the young being full-grown.
5. Falco spaverinus deserticola. Desert Sparrow Hawk.
   They were common on the edge of the canyons, and usually were found near the large tree cactus. They were breeding in holes in these.
6. Megascaps cineraceus.
   They were common; collected several alive by placing an insect net over their hole in oak trees and then hammering on the trees.
7. Micropallas whitneyi. Elf Owl.
   They were common. Would light in trees around the camp, and make their sharp little cry.
8. Bubo virginianus pacificus. Western Horned Owl.
   Saw two in the canyon.
9. Symium occidentalis. Spotted Owl.
   Saw three specimens in the canyon. They were quite tame.

10. Lophortys gambeli. Gambel's Partridge.
    This partridge was very common in the canyons. There were coveys in sight of the camp at about every hour of the day.
11. Zenaidura macrura. Mourning Dove.
    A few were seen.
12. Melopelia leucoptera. White-winged Dove.
    They were very common in the canyons. They have a peculiar soft note which reminds one of an owl's call.
13. Geoccyx californicus. Road-runner, or corn camino, as the Mexicans call them.
    They were very common and very curious. Often when sitting down they would come within six feet of me.
14. Coccygus americanus occidentalis. California Cuckoo.
    Saw two.
15. Dryobates scalaris bandi. Texas Woodpecker.
    Secured only one specimen—saw two.
16. Centurus uropygialis. Gila Woodpecker.
    Were very scarce. Saw a few around the cacti.
17. Aeronautes saxatilis. White-throated Rock Swift.
    These were seen in large flocks up at the heads of the large canyons, where there were large, rocky cliffs.
18. Tyrannus verticalis. Arkansas King Bird.
    Were seen often, but were not as plentiful as some of the smaller species.
19. Pyrocephalus rubinus mexicanus. Vermilion Flycatcher.
    These little beauties were very common in the canyons. They were active and could be seen at all hours of the day catching insects in the trees and up over the mesquite trees.
20. Myriarchus cinerasceus. Ash-throated Flycatcher.
    Often seen.
21. Myriarchus mexicana magister. Arizona Flycatcher.
    Shot three specimens.
22. Myriarchus mexicanus. Mexican Crested Flycatcher.
    Took one specimen.
23. Aphelocoma sieberi arizona. Arizona Pay.
    Were seen at rare intervals at the heads of the deeper canyons; were not plentiful.
24. Corvus corax sumatus. Raven.
    Were common.
25. Lecterus cucullatus. Hooded Oriole.
    Collected one pair; were not common.
26. Papilo fuscusmesolencus. Canyon Towhee.
    Common on the mesquit.
27. Cardinalis superbus. Airzona Cardinal.
    Often seen; secured one pair.
28. Amphispiga bilineata desertuda. Desert Black-throated Finch.
    The Fringillidæ were conspicuous by their absence. The above species and the one mentioned below were the only ones noted. Saw only one pair of the Black-throated sparrow. They were at the mouth of a canyon. Secured the male.

29. Carpodacus cassini. Cassinus Finch.
    Were rather common in the canyon.
30. Laureus ludovicianus excubitorides. White-rumped Shrike.
    Secured one specimen; were not common.
31. Virio bellipusillus. Least Greenlet.
    Common in the canyons.
32. Auroparus flaviceps. Gold Tit.
    Secured the only specimen seen.
33. Lophophaneus wollwecheri. Bridled Titmouse.
    Saw a small number up on the side of a mountain in oak-grown canyon. Judged them to be young ones.
34. Polioptila cœrulia obscura. Western Blue-gray Gnat Catcher.
    Were fairly common in the canyons.
35. Catherpes mexicanus conspersus. Speckled Canyon Wren.
    Secured one specimen on cabin roof. It was the only one seen.
36. Oroscoptes montanus. Sage Thrasher.
    Were common on the lower parts of the mountains.
37. Mimus polyglottus. Mocking-bird.
    Were common in the canyons.

FOOD HABITS OF KANSAS LIZARDS AND BATRACHIANS.

By F. A. HARTMAN, Wichita.

SINCE a large proportion of the residents of Kansas depend directly upon the products of the soil, any animals which help to preserve these products should be of general interest.

It is recognized that birds and animals which prey upon rodents are of great economic importance. Some of our birds give great assistance to the farmer in the destruction of vast numbers of insects. There are other animals which offer a large factor in this destruction of insects—the reptiles and batrachians. Among the reptiles, the snakes do a great deal of good by feeding on obnoxious rodents and some harm in the robbing of bird nests. The turtle lives upon animal matter, a small part of which consists of live insects; the gopher-turtle eats some vegetable matter. The lizards, of all reptiles, are strictly insectivorous, with a very few exceptions. Neither as loathsome as the snakes, nor as lazy, they are looked upon by most people as harmless. There are some people, however, who fear them as they would a poisonous serpent. One need not be alarmed at sight of any of the Kansas species, for they are all harmless. They are, moreover, very useful. The writer has collected data concerning a few of the more common species.

Holbrookia maculata, a squat, stubby-headed, little fellow, common in sandy regions, especially in the sand-hills sparsely covered with vegetation, lives upon grasshoppers and small beetles. The stomachs of three specimens collected in Graham county contained small beetles and a grasshopper nymph. Sixty of these little fellows were kept in captivity for a few months. They thrived on grasshopper nymphs. Grasshoppers which showed no signs of life when put into the lizard cage were never touched. But as soon as a grasshopper would move one of the lizards would creep quietly up to within an inch or two, turn his head quizzically then suddenly grab the unsuspecting victim and jerk his head from side to side in swallowing it.

There is a brown, medium-sized, sharp-scaled lizard (*Sceloporus undulatus*) that abounds in sandy regions which are covered with cactus, weeds, or scraggy brush. It is found especially along the banks of streams. The examination of five individuals showed that they had eaten grasshoppers (mostly nymphs), ground-beetles, and

leaf-hoppers. These lizards are often found climbing weeds or brush. One of this species was observed clinging to an old sunflower stalk three feet from the ground. In color the lizard mimicked the weed so perfectly that it would escape ordinary notice. It was, no doubt, lurking there for the purpose of catching insects.

The Horned toad (*Phrynosoma cornutum*) examined had eaten a great number of small beetles. This species is not as common in Kansas as it was formerly.

The Glass snake (*Ophisaurus ventralis*), on account of its size, eats as much as some of our snakes. A specimen collected at Lawrence contained three large grasshoppers, one cricket, and one large caterpillar.

The Long-tailed swift (*Cnemidophorus sexlineatus*) can run with such speed that no insect can escape it, except by flight. Even the wary tiger-beetle does not escape. This lizard is very long and slender and runs as quick as a flash. It abounds in grassy, sandy regions. It lives upon grasshoppers, cockroaches, tiger-beetles, and other beetles.

Eumeces obsoletus, the common scink, a large, powerful, smooth-scaled lizard, will tackle animals as large as itself. One of these, kept in captivity with some snakes, attempted to kill a Spreading adder by seizing it by the neck and shaking it. The adder was a foot long. The two were separated after the process had gone on for a time. This specimen was put in a cage with a young Collared lizard (*Crotaphytus collaris*) about three inches long. In a few days the cage was opened and nothing but a few mutilated bones of the smaller lizard were to be found. The scinc had evidently devoured the little fellow and ejected the bones. This species is found under rocks on rocky hillsides. The stomach examined contained large grasshoppers and crickets. One specimen, in addition to this menu, had eaten a large ground-spider.

Eumeces guttulatus, the Blue-tailed scink, in form very much as the above but hardly more than three inches long and of a bluish-black color; hides under rocks. A pretty little fellow, not so repulsive as his close relative, *obsoletus*, he darts among the rocks with such agility that he is caught with great difficulty. The stomach of a single specimen contained a fly, a spider, two leaf-hoppers, and a cricket. Two specimens kept in captivity ate flies and grasshoppers with avidity. Five specimens of *Sceloporus undulatus* were placed in the same cage with them. Three of these were young, varying in size from three-fourths of an inch to an inch and one-half in length. In a few days no trace of the young

ones could be found. A little later one of the old ones was observed to be crawling about merely by the use of his front legs, his hind legs apparently useless from some injury. A few days later a Blue-tailed scink was caught in the act of shaking a *Sceloporus* by the back of the neck. The *Sceloporus* was fully as large as the scink. On examining his hind legs they were found to have been chewed and the bones broken. This shows how aggressive and warlike these little scincs are.

So we find that lizards live upon grasshoppers, crickets, and beetles, all harmful insects, with a possible exception of a few of the beetles.

Among the batrachians we find a greater range of diet, but on the whole it consists of insects.

Amblystoma tigrinum or Mud puppy, the common salamander, is found in ponds, and naturally lives on water insects, although occasional land forms are eaten. Of three larvæ, the stomachs contained, respectively, four, seven and two water-boatmen; in an adult form one ground-beetle was found. In another the stomach was distended with mud.

To the common toad (*Bufo lentiginosus americanus*) we owe a great deal for its vast destruction of insects. They begin their useful work as soon as they leave the tadpole stage, and have no choice in the kind of insects or vermin they eat. They are, in addition, great gormands. Toads eat mostly at night or in the twilight. Street lights are their favorite rendezvous. Great numbers often congregate in these places. In Kansas City fifty toads were counted under one light at one time. They will run in numbers from two to as many dozen under a single light. The young ones are to be found in swampy places or near ponds. Three young specimens collected in Graham county, about three-fourths of an inch in length, contained as follows: Twelve ants and twelve small beetles, twenty-eight ants and three small beetles, twenty ants and one beetle. A specimen seven-sixteenths of an inch long contained nine snapping-beetles. A specimen one and four-tenths inches long contained four medium-sized ground-beetles. Two adults had eaten as follows: The first, one large *Scolopendra*, four snout-beetles, one moth, and one ground-beetle; the second, ten May-beetles, three snout-beetles, and two ground-beetles. Spiders and phasmids have also been found in the stomach of this species.

A number of toads were collected from three lights at Kansas City at nine o'clock P. M. on June 9. The toads had not been away from their retreats more than an hour or two. From among this

number eleven were taken at random, and the contents of their stomachs examined. The following kinds of insects were found: Cincindelidæ, ground-beetles, crickets, snapping-beetles, leaf-hoppers, ants, *Belostoma*, *Lachnosterna*, grasshoppers, tumblebugs, Lampyridæ, and carrion beetles. The specimen that had had the largest meal contained sixty beetles, three leaf-hoppers, and three ants. No telling how much would have been eaten in a few more hours.

Bufo cognatus, a smaller species, colored with a brighter pattern, and having diverging occipital crests, has practically the same food habits. The specimens examined contained snout-beetles and dung-beetles.

Among the tailless batrachians one of the most interesting is the little cricket-frog, *Acris gryllus*. They abound in swamp streams and roadside pools. They are of a dark color, and many of them are marked on the back by a rusty-red triangle. Out of seven specimens examined from different parts of the state, the following were taken: Ants, a caterpillar, lady-bugs, snapping-beetles, a spider, one small crayfish, and small beetles unidentified. For their size, they eat a fair quantity of insects, and, on account of their number, in some localities, they help considerably in insect destruction. Several specimens of *Hyla versicolor*, the common tree-frog, failed to show any evidence of a meal. A specimen collected by Mr. Crevecœur at Onaga contained one small cricket. It may be that some of these specimens had not had a chance to eat, because they were collected in the spring, before insects were very active. These small frogs live amongst vegetation, and undoubtedly do some good.

Belonging to the family Hylidæ is another rather common frog, the Striped bush-frog, *Chorophilus triseriatus*, seldom seen in the summer, but common about pools of water in the spawning season. This is a small frog, about the size of a cricket-frog, and has three prominent stripes running down the back. Four very young specimens had eaten, as shown by their stomach contents, algæ and ants. Out of four adults collected in the spawning season, two had eaten nothing, while the other two had eaten a spider apiece. These frogs during the summer probably live upon the same kind of food as their kin, the *Hyla*, because they live in the same habitats.

The large Green bullfrog (*Rana catesbiana*) is quite an eater at times. From the stomach of one of these a full-grown sparrow was taken. Young specimens of these species contained remains of water-beetles and ground-beetles. A single specimen of *Rana*

areolata circulosa, collected on the Wakarusa bottoms near Lawrence, contained two good-sized crayfish. These bottoms afford a place for a good many crayfish to dig their burrows. Evidently this frog had been living at their expense. When caught he had taken refuge in a crayfish hole. The markings are very striking, and distinguish it easily from the common spotted frog. It is covered with large, black, circular blotches. It seems to be quite rare in Kansas.

The commonest of all frogs, *Rana virescens brachycephala*, is probably very useful as an insect destroyer. However it does not equal the common toad. The stomachs of this species which were examined yielded the following miscellaneous food materials: Beetles, grasshoppers, crickets, a worm, water-snails, myriapods, and one solpugid. Both the young and adults were examined. In quantity of material they fall far below the toad. The tadpoles of both toads and frogs live upon vegetable matter.

Among the lizards and batrachians the toad stands far above any other member in the number and quantity of insects destroyed. On the other hand, taking the groups as a whole, the batrachians are outclassed by the lizards as insect destroyers. Vast numbers are destroyed by them every summer. One cannot really estimate the value of these small animals.

CERTAIN CONDITIONS TO BE MET BY THE INSECT COLLECTOR, PARTICULARLY THE AMATEUR.

By ELBERT S. TUCKER, Museum Assistant in Systematic Entomology, University of Kansas, Lawrence.

ALL phases of work with insects hold a fascination to the true entomologist. The more difficult the part the more absorbing it becomes, but the most enjoyable feature lies in the collecting. Only a simple outfit is needed for collecting purposes—a net and a couple of poison bottles are usually sufficient—though a few other things which can be carried without trouble will prove useful at times. Provided with such light but effective equipment, what pleasure awaits the collector who is free to rove as he wills through fields and woodland, along streams and shores, or on mountain or plain, in search of coveted insect specimens. While some places are to be preferred above others in yielding results, yet, for such a matter, multitudes of different forms which appear during the warm months of the year generally abound close to one's own home, whether situated in town or country. Therefore, the collector can find much to inteaest him, ready at hand in most cases, wherever he happens to be.

Many persons who cherish a fondness for nature study are busily engaged by day in ordinary vocations, but still no excuse should be made for want of time to collect and study insects, to some extent, if desired, when holidays, vacations and various odd periods of leisure allow valuable opportunities, even if only a few minutes at a time. Besides, entomology as a field for investigation has an advantage over other branches of natural history on account of the great number of insects which fly at night, thus permitting the collection of specimens after daylight has fled. This privilege, which is most munificently afforded on summer evenings, proffers a delightful as well as instructive diversion from one's daily work.

The constant accumulation of specimens, little by little perhaps, here and there, by day or by night collecting, will soon reach proportions of which the amateur collector may justly be proud. In spite of all difficulties to be encountered in collecting, the amateur becomes assured that ample returns will compensate nearly every effort expended. Then an interesting display of material will invite study, provided the collector has exercised good judgment and practice in his efforts. His work, however, is not perfect without

careful and proper mounting of specimens, nor complete without explicit data.

Every definite locality that is given for the capture of a species is important in defining the extent of territory in which that species occurs, and such references, however local they may sometimes be, assist, often appreciably, in extending our knowledge of geographical distribution and in fixing the limits of their life zones. Next in value to the record of the locality in which an insect was taken was the date of capture; without these two most important particulars, the specimens are almost worthless. On the other hand, the records of further particulars learned from observation and experience, will render a collector's attainment of high scientific value.

The designation of captures made at night from those made in daytime seldom receives adequate attention, since far too little heed is given to the use of distinctive pin labels on which the data should be written or printed. The addition of the words "twilight," "at night," and "at electric light," on day labels, will answer most requirements for night collecting.

The triumph that affords the greatest satisfaction in the accomplishment of something worthy of commendation is achieved in the face of difficulties. Circumstances are frequently contrary to one's wishes; still a person need not be dismayed by interruptions nor deterred from a worthy purpose by unavoidable delays. Collecting can go on even if the work of determination lags. Portions of my own collections have been held fully fifteen years before the specimens were thoroughly identified.

A considerable extent of the systematic work in entomology lies beyond the skill, if not the time and facilities, of even the most experienced collector. But such difficulties, which especially face the amateur, are largely overcome through the generous assistance of specialists, who generally desire, in fact ofttimes request, selected material for research study. By taking advantages of these privileges, undetermined material may finally receive satisfactory attention. Without such recourse, the collector would be seriously hampered and likely refuse to collect or at least to save specimens which he could not readily identify himself within the limitation of his own resources. On account of the immense number of different forms of insect life, the specific or individual recognition of every kind of insect surpasses the ability of any one person. Even specialization in a restricted group alone entails slow progress towards perfect identification of species. The interests of entomo-

logical science require the furtherance of mutual relations between collector and research worker, since one needs the other's help. In exchange for his duplicate specimens sent to one or more authorities, the collector learns the names of the species, or perhaps a greater part of them, when reported upon, which service, together with his collecting records, places him in possession of a fund of scientific information that might ultimately be embodied in respectable lists for publication.

ADDITIONS TO THE LIST OF KANSAS COLEOPTERA FOR 1906.

By W. KNAUS, McPherson, Kan.

THE following list of sixty species of Kansas Coleoptera have, so far as I know, never been published in any of the various Kansas lists. Those species followed by the names, Leconte, Horn and Smith are records from Kansas by these authors in their monographic treatment of the various families and genera of Coleoptera, but I believe have not been taken by local collectors.

The species from Douglas county are from the records of Prof. F. H. Snow; those from Onaga have been reported by F. F. Crevecœur; and the other localities, with one or two exceptions, refer to my own collecting.

In the list for 1905, published in part I of volume XX, a few errors occur, as follows: *Bostrychus cornutus* is probably European; *Cartodera argus* Fall should be *C. argus* Reitt; *Oligomerus alternatus* Lec. should be *O. alternans; Petalium seriatum* Lec. should be *P. seriatum* Fall; *Catorama confusus* should read *C. confusum*, and *C. nigritulum* Fall should be *C. nigritulum* Lec.

Thanks are due Mr. H. C. Fall, of Pasadena, Cal., for many of the determinations.

25*d* Cicindela 10-notata Say. Douglas county, 1 specimen.
Notiophilus novemstriatus Lec. Benedict, Wilson county; 1 specimen.
218 Pasimichus punctulatus Hald. Onaga; occurs occasionally.
293 Ardistomis puncticollis Putz. Galena; collected by Ebb Crum.
9252 Bembidium postfasciatum Ham. Douglas county.
robusticolle Hayw.
547 Pterostichus relictus Newm. Douglas county.
567 convexicollis Say. Onaga.
617 Evarthrus heros Say. Wilson county.
623 Amara avida Say. Wilson county.
735 Badister elegans Lec. Douglas county.
800*a* Platynus subsericeus Lec. (Leconte).
922 Callida decora Fab. Douglas county.
927 Philophuga amœna Lec. Douglas county.
1068 Discoderus impotens Lec. Salina.
1073 Stenomorphus rufipes Lec. McPherson and Topeka.
Aleochara kansana Csy. Douglas county.
Aleochara ellipsicollis Csy. Douglas county.
2093 Acylophorus pratensis Lec. (Leconte).
Trichiusa atra Csy. McPherson; several specimens.
Gyrohypnus melanops Csy.

2426 Stenus dispar Csy. Topeka.
2895 Triga picipennis Lec. (Leconte).
Scymnus bisignatus. Medora; 1 specimen.
3992 Eucinetus morio Lec. Onaga.
4376 Limonius ornatipennis Lec. Douglas county.
4662 Chrysobothris æneola Lec. (Horn).
4720 Agrilus arcuatus Say (Horn).
4720 torquatus Lec., var. (Horn).
4745 imbellis Cr. Medora; 1 specimen.
5202 Hydnocera pedalis Lec. Belvidere; one specimen.
Catorama triviale Fall. McPherson; one specimen, taken in June by sweping grass.
borsele Lec. Medora; one specimen, by sweeping grass.
5719 Diplotaxis truncatula Lec. (Horn).
5735 innoxia Lec. (Horn).
5837 Anomola cavifrons Lec. Rooks county, Gove county, and westward.
ludoviciana Sch. Central Kansas, eastward.
6005 Phymatodes decussatus Lec. Wilson county.
6008 Callidium antennatum Newm. Central Kansas; imported in pine lumber.
6398 Goes debilis Lec. Leavenworth county.
6453 Pogonocherus mixtus Hald. (Leconte).
Saxinis knausii Sch. Belvidere and Englewood.
6601 Chlamys plicata Fab. Central Kansas.
6616 Crytocephalus binominis Newm. (Leconte).
6844 Phyllodecta vulgatissima Linn. Central Kansas.
Epitrax numeralis Drury. McPherson; May and June; several specimens, by sweeping grass and plants.
7073 Odontota collaris Say. Onaga.
7719 Salpingus tibialis Lec. (Leconte).
Mordellistena, n. sp. One specimen; McPherson; June.
Xylophilus, n. sp. One specimen; Belvidere; June.
8013 Nomaspis parvula Hald. (Horn).
8378 Apion cribicolle Lec. (Smith).
8413 erternum Smith (Smith).
8416 extensum Smith (Smith).
8422 confertum Smith (Smith).
8424 xnigrum Hbst. (Smith).
8574 Endalus punctatus Lec. Medora; one specimen; June; sweeping grass.
Onychobarris n. sp., near millepora Csy. Belvidere.
9038 Phlœophagus minor Horn. One specimen; Onaga.

V.

MISCELLANEOUS PAPERS.

"NOISE: ITS RELATION TO HEALTH, DISEASE, AND LONGEVITY."
By J. M. McWHARF, M. D., Ottawa.

"DANCES OF THE JEMEZ PUEBLO INDIANS."
By ALBERT B. REAGAN, Mora, Wash.

"CLIMATOLOGY OF KANSAS."
By T. B. JENNINGS, Weather Bureau, Topeka.

"NATURE PHOTOGRAPHY IN KANSAS—WORK OF MR. AND MISS McCOLM."
By GRACE R. MEEKER, Ottawa.

"GAGING OF SEWAGE FLOW AT LAWRENCE, KAN."
By PROF. W. C. HOAD and A. H. MANN, University of Kansas.

"THE ACCURACY OF A MODERN BALANCE AND SET OF WEIGHTS."
By H. L. WOODS and ALICE K. McFARLAND.

"CHANGE IN THE CLIMATE OF KANSAS."
By F. H. SNOW, University of Kansas, Lawrence.

NOISE: ITS RELATION TO HEALTH, DISEASE, AND LONGEVITY.

By J. M. McWharf, M. D., Ottawa.

THIS question has never received a fair consideration at the hands of science nor of the medical profession; we are therefore unable to give as complete status of things as might be hoped for or desired.

The gravity of the question necessarily demands a thorough, scientific investigation of all points pertaining thereto. In our mad rush for wealth, we forget that health, life, in fact, everything, must be sacrificed. Are we to be classed with the "heathen Chinee," the man who has educated himself up to a condition of stolid indifference at the sacrifice of a human life? He looks at his brother as he sinks beneath the wave and never exerts a muscle nor expresses a word of sorrow or regret; the environments do not touch a chord of sympathy, and in all probability are never recalled.

Not many years ago a poor, deluded, foolish fellow conceived the idea that he preferred to live in New York or not to exist at all. The noise of the great city he could not endure, especially ths ear-splitting noise produced by the bells of a neighboring church; he therefore sought relief by committing suicide. This is an individual case, and yet there are thousands of cases to-day where people are made ill, or are committing slow but sure suicide, as a result of useless noises.

Noise must be classed as a great factor or element as a non-producer of health. This being true, it is of necessity important, from a medical standpoint. Every scientific man, and especially every medical man, should have a word to say and a duty to perform along this line. If we study this question from a physiological standpoint, we are forced to admit that rest is essential to health and longevity. This being true, over or persistent stimulation of an organ or a set of organs must necessarily be pathogenic. The greater the tension of the machinery in action, the less the durability. Herbert Spencer, it is said, used a mechanical contrivance and plugged up the auditory canals, thus securing relief from noise. Such action is not commendable, yet we are forced to admit that the relief would be a happy combination of circumstances.

There may be, stored away in the brain of some aurist of to-day, a healthy and practical method whereby one could, at will, shut out all unwelcome sound; such inventive genius would be a great benefactor to humanity. Should we consider our question sociologically, certain factors confront us. There is an unrecognized duty, as regards noise, that rests upon a physiological and esthetic basis. Perfection in any organization demands delicacy and accuracy of response to a physiological stimulus; whatever retards or prevents this must be antagonistic to the welfare of society and to its progress. This is a brutal, noise-making period, prolific of results. The ceaseless bruising of the mind and destruction of the nervous system tend to produce disease and shorten the natural duration of life. The auditory or nervous mechanism with which it is connected must be blunted in sensitiveness, crushed, and stupefied, or a pathological result will follow.

Imperatively the people are divisible into two classes: First, those whose nervous systems and minds are becoming mechanicalized, anesthetized, and brutalized; second, those who, having failed to kill sense and mentality, have developed diseased reaction.

From this hypothesis we arrive at the following conclusion: That noise may be considered an agency which produces one of two conditions—a sickly or a savage individual. Civilization to-day is bearing upon its bosom a self-poison, the result of which will be its own downfall; there will be a loss of refinement and delicacy of the senses, and this will produce a retrograde movement toward barbarism. Should this condition prevail with us, then of a necessity we are becoming neurotic, hysteric, and neuresthenic. Society will then progress toward a crowd of the mentally stupid or the hyperesthetically morbid. Social amusement to-day is but a game of battering and spurring, jaded and blunted senses, or at least ministering to sense diseases.

The medical profession, taken in its narrowest sense, is bound to reduce the amount of noise-making, for noise not only engenders disease, but prevents its cure and hastens to a final termination. Statistics corroborate this statement. It is authentically stated that in the city of Philadelphia there are upward of 4000 needless deaths, and 8000 were made ill each year from purely unnecessary noises. What may be true of Philadelphia is an axiom in regard to other large cities; while it is impossible to secure exact data upon the points in question, there is a degree of certainty in the hypothesis taken. Many of the sick are kept in their homes, while others are cared for in hospitals, that, unfortunately, are too often

located in the most densely populated portions of the city; in either case, noise may be the disturbing factor. The sick must seek seclusion, and quiet should be their environment. Every intelligent physician is cognizant of the fact that quiet is essential in the sick-room. He fully understands that noise has been the baneful influence—the destructive factor—many times hindering his efforts to cure.

We are a reckless people in the production of unnecessary noise. Not satisfied with what can be accomplished during the day, this disturbance is kept up long into the night, in many cases during the entire sleeping hours. Night is frequently made hideous with drunken brawls, whistles of locomotive-engines, street-car whistles or bells, laying of railway-tracks, the paving of streets, etc. In many instances this work is necessary only for the advantage and profit of mercenary corporations, and yet the authorities have no power, and, should they possess it, they will not make an effort to repress the evil. Being a freedom-loving people, we submit to this tyrannical master who knows no race nor condition; the monotonous grinding goes on; one or a comparatively few are benefited, while a thousand are tortured and outraged by this bedlam. It is claimed that ten per cent. of the people go to church; then why annoy the other ninety per cent. with the sound of bells which are rung only for notification? Has the ninety per cent. no rights that should be respected? Have not the sick rights that should be recognized? The milkman, the cartman, the pedler, the hawker, the ragman, and, last but not least, the girl who splits her throat warbling, all bawl and howl with such a degree of hideousness that they can be heard from one to several blocks away. Do you wonder that the nervous system is broken and the individual driven to desperation or self-destruction? We are a fast people, living in a fast age, rushing forward in mad frenzy toward dissolution or a premature old age.

Noises should be classified as necessary, partially necessary, and totally superfluous. If considered upon the plan of exclusion of the latter, we would get rid of at least seventy-five per cent. of all noises. This work is in harmony with an advanced public welfare, and we should have an organization to be known as "The Association for the Public Good," the duty of which is to see that all loafling rowdies, howlers, whistle-blowers, bell-ringers and song-warblers be hushed.

The block, cobblestone and brick pavements are noise producers; also a prolific source for the culture of filth and disease germs;

they should be abandoned and in their stead the asphalt pavement, which can be flushed and kept sanitary, should be used.

The character and civilization of any country are determined by the amount of unnecessary noise it endures. If noise is considered only as a discomfort, and not antagonistic to our physical well-being, we need not expect any action to be taken as a preventive, but just as soon as this nuisance is unmasked by the searchlight of a perfect investigation, prompt action will be taken, and it will cease to be a menace to health, disease, and longevity.

DANCES OF THE JEMEZ PUEBLO INDIANS.

By ALBERT B. REAGAN, Mora, Wash.

THE Jemez pueblo Indians are a semicivilized tribe residing in the northwestern part of New Mexico, about sixty miles southwest of Santa Fe and fifty miles north of Albuquerque. They, like their pueblo neighbors, differ in many characteristics from the nomadic tribes, devoting their attention principally to the cultivation of the soil and the raising of stock. They live in houses built of stone or sun-dried brick.

They have a division of labor, the women doing the house work, the men the work in the fields.

Their civilization dates back to a period anterior to the arrival of the Spaniards; and, owing to their isolation and manner of living, they still retain their ancient language, customs, superstitions, and religion, though all of them talk the Mexican language and are adherents of the holy Roman Catholic church.

These Indians are religious in the extreme; every move, every voluntary act, even the smoking of a cigarette, is performed with some religious end in view. They are worshipers of nature, and they endow each object with its counterpart spirit. The sun, moon, stars, clouds, lightning, rainbow and snake are their chief objects of worship. Symbols of these objects of worship are painted on their dancing regalia and in their dwellings, secret apartments, and religious halls. In front of these symbols they pray and sprinkle corn-pollen or meal, usually morning, noon, and evening, they believing that the symbols have the power to carry the prayers of the children of men to the deities they represent.

Halls are built by these people for the purpose of worship, and many of their dwellings have secret religious (dark) rooms in them; besides, many of the houses have blind closets. In the latter the things of a religious character, which the Jemez does not desire the public to see, are stored away and sealed up till needed again in religious worship. In the dark room are the altars, the idols, and many symbolic drawings and paintings. In this room also, lying beneath the sacred symbols, are bunches of the downy eagle feathers, so sacred to the aborigines of the region. Among these bunches of feathers, bowls of sacred dust—corn pollen and meal—are setting. In this room the "family worship" is carried on, and in it the oldest woman of the family sprinkles the sacred

JEMNEZ PUEBLO AS IT IS TO-DAY.

dust three times a day in front of the symbols and idols, the latter being crude figures of men and animals, carved out of wood or stone.

The halls of worship are large, rectangular, flat-roofed buildings, the inside walls of which are decorated with symbolic paintings of the greater and lesser deities of the Jemez tribe. Before these sacred emblems the "cacique," or sun priest, sprinkles the sacred dust, and prays both at the beginning and at the close of any special ceremony. In front of these same paintings the dancers and clowns train themselves for special occasions, and from their presence they emerge from the building to dance and perform before the public in the plaza, and to their presence they return at the close of the public ceremony, to be sprinkled with the sacred meal and to receive the blessings of the gods.

While United States Indian farmer at Jemez, in 1899 and 1900, I visited each of the halls of worship (estufas) at will, being with the Indians in them as many as six nights in the week. I also examined the blind closets and secret rooms in their dwellings, and visited their open-air performances held during my sojourn there. Thus was I enabled to see many things of interest. Among these were their dances. Observations on these I give below.

THE MASKED DANCE.

One morning soon after I went to Jemez an "Ahoo, ahoo, ahoo, ahoo, ahoo," broke the stillness of the morning air. A masked sun-dance was commencing. The "Ahoo, ahoo, ahoo," grew louder and louder and became a more basic, hideous sound, as sixteen strange-looking creatures issued, one after another, from the passageway in the roof of the rectangular sun-house. They were the clowns that, according to the Jemez belief, represent the principal gods, the sun, the moon, the morning star, and the evening star, on all special religious occasions. All of these clowns were gaudily dressed. All had conspicuous head ornaments, and all wore circular masks some eight inches in diameter. On these were painted the gods they respectively represented, together with paintings of clouds, of lightnings, and of snakes.

The arms of these clowns were naked. They wore leggings and moccasins tinged in red. Their yellow-painted bodies were wrapped in richly colored blankets or robes, on which were embroidered, in characteristic colors, figures of the sun, of the moon, of the great stars, of the good and evil snakes, of the rainbow in the west and the rainbow in the east, and of the four pillars of clouds—the steps from earth to heaven—all making a fantastic display.

The head ornament usually consisted of eagle feathers so arranged on a buckskin covering as to represent the spread tail of a bird with reverse side presented to the front. Back of this fan of feathers were paintings of the greater gods, whose outlines were formed with tiny images, beads of turquoise, and shells of various kinds.

The masks, with respect to the figures painted on them, were four of a kind. The symbol which the wearer represented occupied the central position on the mask. These central figures consisted of a disk surrounded by concentric bands in the sun and moon drawings and by points in the star symbols. The disks of all the figures were red, except those of the moon, which were white. The inner band of the sun was black, the outer was composed of rays of red alternating with outer spaces of yellow. From this outer band there projected darts in red; one to the right, one to the left, one toward the heavens above, and one toward the earth beneath. The white disk of the moon was surrounded by a wide yellow ring. From it four groups of peculiar-looking figures projected, one toward each of the four cardinal points when the mask is laid flat on the ground, with one of the groups extending in a cardinal direction. The Jemez Indians suppose that these groups represent the rays of the moon. Each group consisted of two yellow figures inclined at a small angle from the perpendicular and from each other. Each of these terminated at its outer end in a blue disk. The whole looked much like a half-burned cigar, the blue disk representing the ashy end. The stars were four-pointed. The points of the morning star were black, those of the evening star yellow. The disks of all the central symbols were god faces. The eyes were triangular in shape, the mouth rectangular. Both the eyes and the mouth were painted black. The outer figures on the masks were at the right and at the left of the central emblem. The drawings on the one side were the counterparts of those on the other. The four pillars of clouds, painted black, projected out and extended as a succession of steps along the rim of the mask almost from its lower part, as the mask is worn, to its upper part. From these cloud-pillars, or "steps from earth to heaven," as the Jemez believe them to be, four figures, painted in striking and characteristic colors, extend, one from each cloud projection in toward the controlling symbol. The upper figurere presented the bolt lightning; the next lower a red, zigzag-bodied snake, having a blue head from which a horn curved backwards like a goat's horn. This figure is the emblem of evil. It is the Indian devil, Sawah. The

third from the top was a sinuously curved yellow figure which terminated in three green buds. It was drawn to represent the flash or heat lightning, which the Jemez believe is the god of bloom. The lower figure was zigzag, a blue-bodied snake, having a green head, with horn turning backwards, similar to that of the red snake above described. This snake is the representative of good. It is considered by the Indians as the producer of rain, as being the genius of the watercourses.

The "Morning Star" in one of the dwellings at Jemez. (By permission of the Bureau of Ethnology.)

The dancing skirt and belt.

As soon as the god representatives had descended from the roof of the estufa they began to dance and crow-hop about, keeping up their ear-grating "ahooing" all the time. This they did for about ten minutes. Then they began to march around the village, if march it can be called. They advanced in a long, drawn-out column. Some crow-hopped it along; some jumped like a man, others like a frog; some walked with a cane, mimicking an old man; the cane was tri-colored in red, yellow, and green. Some, leaning forward on short canes, walked on all fours. Others strutted about like a turkey-gobbler. Occasionally all stopped a moment to pose. In this act they usually stood half erect, threw their hips backwards, contorted their bodies, and brought their heads in a position so that the circular mask presented a full front to the god of day, or to his place of rising. At the same time they prolonged the "ahooing" and gave it an emphatic accent. In this manner did they march and pose till they had encircled the whole village and

returned to the public square in front of the estufa. From that time on they mingled with the populace in the streets and plaza, feasted, danced, crow-hopped, or posed, as the "spirit moved" each individual or the whole group collectively till the close of the dance.

Soon after the god-clowns had begun their march around the village twelve men, dressed or undressed, as each one's fancy dictated, their faces whitened with paint, issued from the estufa, and began to chant a rude rhythmic shouting in the minor key; the time was beaten with a single stick on a drum made from a hollow log. These musicians advanced in a body through the plaza, keeping time with their feet and gesticulating in a manner intended to convey the meaning of their song.

As soon as the musicians were far enough from the estufa to give room, the dancers issued from that house and formed a fantastic procession in double column, two men abreast, then two women, and so alternating till the procession was completed. The men stamped and the squaws tripped lightly, but all were keeping time. They presented a weird appearance, tricked out in their gaudy apparel and ornamented with flashy trinkets. The hair of the men was worn loosely; tufts of feathers fluttered over their foreheads; while around their necks and dangling over their naked chests were strings of shell beads, turquoises, bright pebbles, feldspar, obsidian—anything, in short, that glitters and shines. Fastened about the waist and reaching nearly to the knee, a rude kilt-like garment, dancing skirt made of buckskin or sacking, hung and flapped. It was ornamented with an embroidery of red and black threads. Below the knee, garters of buckskin, stained red, yellow, and blue, formed a fringe, to which were attached tortoise-shells and rattles. The ankles were encased with strips of black and white fur. From the waist a fox skin hung, fastened at the back and reaching almost as low as the heel. Each man carried a tuft of hawk's feathers in his left hand, while the right grasped a rattle fashioned from a gourd, partly filled with pebbles. The women wore their ordinary black dress, trimmed, however, with a profusion of necklaces, strings of beads, silver badges, wristbands, and ear pendents, while in each hand was borne an ear of corn, which was wagged from side to side. Both the men and women wore masks and striking head-dresses. The masks were heart-shaped, with the exception of the base, which was a straight line. They were made of buckskin, were painted blue or green, and, like the circular masks, had triangular holes cut in them for the eyes and a rectangular hole for the mouth. The head-dresses consisted of a

board-like piece of wood about fifteen inches long and eight inches wide. One end of it was carved out, in arch shape, so as to fit the head transversely just in front of the ears. The other end was trimmed in what resembled a triple turret, squarely notched. This head-piece was painted green and decorated in symbolic figures in red and yellow. White feathers fluttered from each of the three turret-like projections. This peculiar head-gear was held in place by strips of buckskin attached at the center of the hollowed-out arch and knotted about meshes of the dark, streaming hair, and also by a cord passing beneath the chin from the ends of the board at the foot of the arch.

Just as these dancers had formed in column for dancing, attention was suddenly attracted toward the passageway of the estufa, whence were issuing a dozen or more strange-looking beings. They were the "funny men." They did not walk into the plaza, neither did they dance into it, but rather tumbled into it, running, hopping, stumbling, cutting capers, like a troupe of ill-trained clowns. In fact, in their clumsy way, they imitated or acted out almost every silly performance known to the clown profession. And the lookers-on enjoyed their tricks and pranks immensely, to use the common phrase; they hailed the clumsy attempts at a joke and the coarse sallies of wit with shrieks of laughter. These "funny men" were attired only in breech-cloth; their bodies were daubed in transverse rings or bands of black and white; and their heads were decorated with corn husks instead of feathers. They were, indeed, "funny men" in appearance as well as in action.

While the clowns was thus performing, the column dancers moved about the whole plaza in a forward movement, the men gravely stamping, the women gracefully tripping. When the entire plaza was completed in this processional dance, the "couples" separated and changed places, all turning and facing each other, suggesting by their movements the flexures of a closely folded ribbon. The "couples" then reformed, the double rank strung out as before, tramping in a wide circle to the rhythm and measure of the monotonous music. The faces were now reversed, and they danced in double column back to the starting-point. A rest was then taken.

The very moment that the dancing ceased, the "funny men," who had been resting for a few minutes, resumed their performing with increased vigor. One funny man climbed a tree backwards. Another snatched a millstone and slab from the grinding box in a house and, rushing to the plaza, commenced grinding sand upon

it, singing in mimicry all the while, and putting handfuls of sand in his mouth now and then. He was in this manner mimicking a squaw grinding meal. Four or five more played a farce in representation of the immorality of the place. Another got the skull of an elk and began to beat it, while several of his fellows danced the double-column dance. As they were thus dancing, another one of the order walked stately in a reverent manner to the column and, as he prayed in jest, sprinkled each dancer with sand and ashes. In this manner did he mimic the sun priest sprinkling the dancers with sacred corn pollen in the estufa before they issued from it to dance in the plaza. Just as the mock dancers were dispersing, a funny man tumbled out of a house with an ear of corn in his hand. Reaching the dancing area, he began to gnaw the ear like a dog does a bone. Instantly another dog-acting man began to snarl and growl, and finally sprang upon the bone-gnawer in a manner that would make any stranger expect to see a genuine dog fight. At that moment the attention of every one was attracted from the pretended dog fight by the shrieks of the girls and women. The clowns were making sallies on them. Some of the younger men of the fraternity were trying to embrace the older women; some of the older men the young girls. This teasing of the women lasted for a minute only. Then all the "funny men," acting upon a previous plan, tumbled and rolled over each other towards where the war captain was standing, until they were within a yard or so of him. Springing to their feet they seized him and carried him on their shoulders to the center of the public square. Reaching it, they placed him on a piece of buckskin and, in a body, demanded a speech, the chief "funny man" introducing him to the motley multitude in these words: "Here is our war-captain. He is a brave man. He has killed the bear in his hole. He has been the hero in many a religious hunt. He has captured the eagle alive and unhurt. Years ago he fought the Navajos and drove them even to their hogans in their own land. Aye, he is brave! He would fight even the demons of the land of fogs and storms. He is a brave man. Hear him."

Tiring of being thus made fun of, the war-captain turned a flashing eye upon his tormentors and said: "You shall have a speech." Then without further ceremony he proceeded; "This earth is flat and round like a pancake and is known to possess four places of habitation, situated one above another. Each has for its roof the floor of the apartment above it, except this one, which has the sky. A long, long while ago our people lived in the apartment

beneath this one. For a long time they lived there. Finally one day a man saw a hole which led up through the roof to this world. He crawled up through it and all the people followed him. The mouth of the hole being in the far, far north, a council was called. At this meeting the 'principals' decided to move toward the noonday sun. Said they: 'The sun warmed the place from which we came; therefore, by moving towards it this earth must become warmer.' So they began their march over mountains of ice and snow toward the boiling ocean. For a long, long time they journeyed; but the land of sunshine was not yet reached. On, on they marched till their food supply became scanty and their blankets became worn out. Then one by one they died of cold and hunger. For a while those who survived kept up courage even under the adverse conditions, and continued their onward march. At last, however, their numbers being so depleted, they became despondent and wished all to die. At this juncture the mother god, the moon, prayed to her husband, the sun, to save the remnant of men, their children. So the sun took one of the survivors of our people, painted his body in transverse black and white bands, decorated his head with corn husks, and suspended an eagle feather behind each ear. As soon as thus painted and decorated this man became a 'funny man,' and began to dance, cut capers, and make grimaces. So interested did the people become in his performing that they forgot their sorrows and became glad. They then resumed their journey, which they continued till they reached the confluences of the Rio Grande.

"Here in this valley they ceased their wandering and took up places of abode. Being few in numbers and not being trained in the arts of war and defense, they were afraid of the savage tribes, the Comanches, Apaches, and Navajos, that dwelt in the region. So they established their places of habitation in narrow canyons, along cliffs, and in caves. In these they lived a great, great while, subsisting on the grain they raised in their fields and on the game so plentiful in the country at that time. Then the savage hordes began to make inroads into the territory. They killed all the game, or, by their presence, it was made unsafe to hunt. They took the fields one by one. They drove the people to the cliffs and caves; and then either captured these strongholds by storm or starved the people until they came out of their own accord and gave themselves over to be slaughtered or to be enslaved. Only a few places still held out, and these were reduced to such straits

that their capture, followed by the massacre of the prisoners, was daily expected. Certain was their annihilation.

"Again the mother god prayed to the sun to save their children, and a second time the great father came to the rescue. At this time he placed among them a 'knowing man,' whose name is Montezuma.

The Pueblo dancer (back view.)

The head ornament (feathers and and spruce twigs removed.)

"Montezuma defeated the enemies, raised the siege of the caves and cliffs, and drove the savages out of the narrow canyons. He trained the people in the arts of war. He led them out into the open country. He routed the hostile tribes in encounter after encounter, and at last expelled them from the region. He instructed the people to build villages in horse-shoe shape with continuous outer wall, so that they both served as places of residence and as fortifications. He taught them their religious rites and ceremonies. He instituted the sacred hunts. He taught the people to paint their houses and edifices of worship in representative figures of the gods. He made the column dancers the sprouters of grain; the 'funny men' the maturers of grain and of everything that lives and grows upon the earth. To the god-clown dancers he gave the power to represent men before the deities. To the medicine men he gave the power over the 'sick' and over death. To the

sun priest and his aids he gave the power to intercede between those above and men.

"For a long, long time he lived with them, extending their territory, building pueblos, and erecting temples to the sun. Finally, after he had made them a powerful and prosperous people, he called them all together and told them that there were many peoples that he must teach as he had taught them, and that he must go and instruct them. 'Then,' said he, 'when I am gone you will neglect to do the things that I have taught you. Therefore will my father, the sun, come in his wrath, destroy your pueblos, and give your fields to another race. After that will you return to do the things I have commanded you. Then when you have returned from your evil ways will I come on the wings of the morning, in the chariot of the sun, expel the intruder from the land, restore you your ancient possessions, and establish you in all your former glory.'

"After Montezuma had departed the people did exactly what the great man said they would. They departed from keeping his sayings, quarreled among themselves, and finally became divided. Our division came to this valley; the other went to Pecos, over the mountains toward the rising sun. In this valley our people builded village after village, only to have an earthquake throw them down or to have them razed to the ground by some of our many enemies. Finally only one village remained. It was situated on the isolated mesa yonder, at the junction of Guadaloupe and San Diego canyons. Against this place the palefaces came with their cannon, and, after a many days' battle, reduced it to the mass of ruins it is this day. Some of our people escaped to the Navajo country, but the greater part of them were captured and reduced to a state of servitude. While thus under Spanish yoke the people built the village and church of San Juan de los Jemez, at the boiling springs (Perea), and the village and church of San Jose de los Jemez, at Canyon, the ruins of each of which still remain. Then the Indians rose against this race of intruders (1680) and killed them all at the two villages. But more palefaces came and took possession of the land again. This time they moved us all to the valley where we now live. Since then have we done penance and mortified our bodies to appease the wrath of the great father. And each morning at the early dawn we send a man to the top of the mesa yonder to see if the great Montezuma is coming with his father on the flaming wings of the morning to

expel this race from our land and restore us our ancient possessions—"

The drum-beat and the monotonous chanting of the musicians drowned the war-captain's voice. The double column reformed and the dance was resumed. Around the plaza the dancers proceeded as before till the processional movement was completed. The sowing-and-planting act was then given. In this act the columns separated and faced each other. The dancers kept time with both the hands and the feet for a minute. Then the columns joined at the ends and spread out in the middle area so as to form an ellipse. Around this all danced in a side movement to the right till each individual faced his respective partner again. Then the partners passed each other in a vigorous forward movement, turned quickly to the right with sweeping motion, and leaned forward nearly to the ground, the men swinging their gourd rattles as if sowing grain, the women sticking the ends of the ears of corn in the ground in imitation of planting corn.

At this instant the women rushed out of their houses with baskets of eatables, ears of corn, gourds, melons, wheat bread, corn cakes, etc. These they threw up into the air in all directions. When the baskets were emptied, they replenished them and tossed the contents toward the abode of those above. Of these eatables whoever could catch anything that fell proceded to do so. A general scramble followed, which would remind one much of a sheep-salting scene, or probably more like feeding swine in a trough in the center of the hog-yard. In this act of throwing heavenward the food which heaven has enabled it to raise, the whole tribe displayed its gratitude to those above, and the dance was the harvest-dance.

Thus were the varied scenes continued throughout the entire day. Then all lined up in double column with columns facing each other. Between these lines the cacique and his aids marched backward and forward for a considerable time, sprinkled their hearers with sacred meal, and prayed to their gods. This scene closed the dance.

THE OPEN-PLAZA COLUMN DANCES.

These dances are similar to the masked dance above described, except that none of the actors are masked and only the women wear head ornaments. At Jemez the clown element is usually wanting, but at Zia pueblo it is represented in its full strength. These dances are had on Catholic feast days and follow mass at the Catholic church. The image of the saint of the day is carried to a

booth in the plaza by a procession from the church before the dance begins. The dance in honor of San Juan (June 24) and that of the patron saint, San Diego (November 12), are the principal dances of this type. The latter is followed by an elaborately prepared feast. The former, besides the feast element, has a mock torrel combat (bull fight) preceding and accompanying it, a "gallo" (rooster) race between acts, and is followed by a water-throwing performance.

The torrel combat begins the evening of the 23d of June, continues in the streets and plaza and around the church while mass is said on the 24th, and flanks the procession with the image on its way to the plaza, and keeps up a general hurrah throughout the entire day. In this peculiar mock performance a man leading a mock bull—a bull hide stretched over a wooden frame supported by one or more men with head and body obscured in the frame—enters the plaza followed by a dozen or more rough, dirty, shabbily dressed, slouch-hatted boys and men, representing Mexican cowboys. At intervals these cowboys tease the bull with sticks till he gets enraged, bellows, and charges upon them. Feigning to be overcome they fall before him in the mud and water, if any is to be found, and are trampled under foot by the enraged "beast." Being then free, the "beast" charges upon whoever may chance to be in the street at the time, making women scream and scaring children nearly to death. The keepers, then wallowing in the mud till it would be hard to tell by their appearance that they are human beings, make chase after it, and after much cracking of whips, bellowing and hallooing they recapture it. In the intervals while the mock bull is quiet its keepers take it from house to house, and from the inmates receive offerings of bread and other eatables, to be presented as an offering to the gods whose symbols are in the estufas.

In the "gallo" race, all the boys whose given names are John (Juan)—as it is St. John's day—have to furnish a rooster each for the race. These roosters, one at a time, are buried in the soft sand in the plaza, all but their heads. Then practically all the young men of the village, mounted on horseback, gallop by where it is buried, lean over in the saddle, grab at its exposed head, and in case any one of them succeeds in seizing it, he endeavors to pull it, struggling, from its buried position. When once it is in possession of a rider, the real race begins. All try to take it from him, while he, with horse at a full run, pounds his opponents with the squawking chicken as they gallop over hills and valleys and through canyons.

At last an opponent gets a hold of the fluttering fowl. Then they pull till the rooster is literally torn to pieces. Then they contest for the pieces in the same manner till there is not a piece left large enough for two people to get hold of. Then another rooster is buried in the plaza and the race is resumed. Thus is it continued till all the Juans have furnished their respective quota of roosters and until every participant in the murderous race is as bloody as though he had been in a gladiatorial contest.

In the water-throwing performance the women carry water to the house roofs till they have filled every water-containing vessel they have. Then, just at dusk, all the men of the village, with clothing removed, ride through the streets and close to the houses in every direction at a full gallop. As they do this the women throw water on them from the housetops. This performance is a prayer for rain.

THE CEREMONIES OF THE DEAD.

Immediately after a Jemez dies he is buried, usually with his personal belongings. Then the women of the family, aided by the medicine men, draw on the adobe floor of the living-room of the house of the deceased a large sun circle, with four projecting darts of protection, one in each of the four cardinal directions. Within this circle they then place a small, crudely carved wooden effigy of the dead one. Over this they throw a new piece of cloth. Then on one side of this effigy they place a new earthen jar filled with water; on the other side a basket of eatables, that have been prepared since the death of the deceased. These things they furnish so that neither thirst nor hunger should cause the traveling spirit to suffer. Furthermore, as the road the soul has to travel is long, dangerous, and beset by evil spirits lying in wait to capture the defunct or hamper his ultimate felicity, they lay beside the image a small war-club and a bow and some arrows, within the representative circle of the god of day, to protect the deceased from harm in his transit. Moreover, to render the journey safe beyond a doubt, they then draw without the circle the footprints of the great Montezuma, the "road-runner," who protects the soul in its journey to the abode of the good Indian dead.

As soon as these things are done, the relatives gather around the image and the drawing and weep, sob, scream, yell, howl, dance, sprinkle sacred meal and corn pollen, and pray loudly to those above for the safe journey of the departed soul and its arrival in the land of bliss. This performance is continued for four days. At about three o'clock in the afternoon of the last day the man an-

INDIAN DWELLINGS, SHOWING THE OVEN.

nually appointed for the purpose goes to the house of the deceased, obliterates the sun drawing encircling the image of the dead, carries the effigy, basket of eatables, water-jar and everything that pertained to the departed to the edge of a canyada to the east of the low mesa east of the village, and hurls them to the valley below. Over them he then sprinkles sacred meal for a moment. This completes the ceremonies; the journeying soul has reached the land of bliss.

THE ANIMAL DANCE.

In the first act of this dance, as seen by the writer in February, 1900, the medicine-men took all their medicine accouterments to the plaza and laid them in a row in a line with the sun, with the most important one, according to the Indian notion, heading the list, then the next most important, and so on till the long row was completed. Beginning at the head of the list, they were arranged as follows: Idols, bowls of corn pollen and corn-meal, groups of eagle feathers, medicine beads, the skins of snakes and birds, the left front legs of bears, bunches of rabbit wool, and the head coverings of beasts. When the things of medicine were arranged, the men of the village, followed by the women, passed down the long line in a stooping position and, each one having blown his breath on his left hand, stroked the curios one by one with it as he sprinkled the sacred meal over them at the same time with his right hand. The Indian believes that the strength, cunning or health powers of the medicine things they thus stroke and sprinkle with sacred meal will be imparted to them.

As soon as all had stroked and sprinkled sacred dust on each of the things in the medicine line the curios were removed from the plaza, and two men, carrying parallelepiped-shaped drums made of corn husks, entered the plaza and seated themselves on opposite sides of the public dancing area so as to face each other. They then began to beat their curious-looking musical instruments with drum-sticks that resembled potato-mashers, except that they were were much larger. Scarcely had they seated themselves when the caciques and "principals" gathered around them and began to chant and gesticulate to the earth, the animals, and the other sacred things on the earth, and to those above.

This chanting was only just beginning when men, dressed in the skins of animals or birds, all wearing masks as near as possible in the natural shape of the head of the animal or bird they respectively represented in imitation, came cantering, galloping, crawling or "flying" from one of the dressing-rooms to the plaza and com-

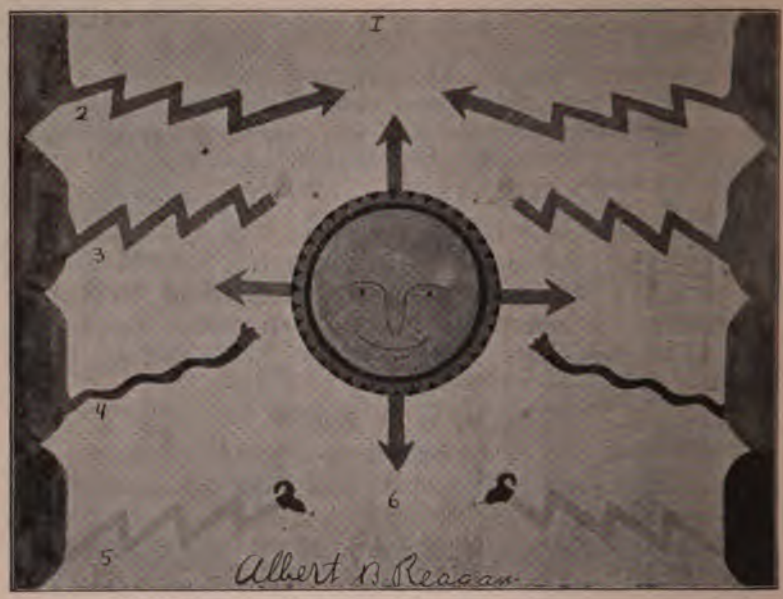
menced performing according to their respective kind. The buffalo pawed the earth and bellowed. The rabbit and the deer leaped from place to place. The turtle proceeded slowly to move about. The turkey gobbled and strutted. The coyote howled. The bear growled. Followed by the chanters these odd performers moved slowly across the plaza till the whole public space was danced over. The cacique then sprinkled all the participants with sacred meal. The actors then dispersed. A new "set" formed, and the previous extravagant actions and strange ejaculations were gone over again. This performing they continued till "Sol" began to hide his face beyond the western highlands. The cacique then sprinkled all present with sacred meal, and the animal dance was completed.

THE MEDICINE DANCES.

These Indians, like all Indians, have medicine dances to cure the sick. These are usually held at night. During them the chief medicine-man sprinkles the patient with sacred meal, prays to the gods, contorts and otherwise mortifies his own body, doctors the patient by a crude process of massage, and occasionally gives him root-tea to drive "sick" away. While he is doing this a houseful of nude men often dance around the couch of the sick one. These dance and chant with the doors of the room closed till the air in the room is nearly foul enough to take one's breath. When they have performed as long as they can stand it in the ill-ventilated room they rush out into the streets and plaza and run hither and thither, uttering shriek after shriek that would make any white man's blood run cold. This shrieking is done to drive out the evil spirit "sick." The sick one usually dies.

THE BOW-AND-ARROW DANCE.

At dusk the evening before the dance, as seen by the writer in August, 1900, the cacique and his aids made the rounds of the village, prayed, and sprinkled corn pollen in every house and over each inmate of the same. Then to the estufas they proceeded, and sprinkled the sacred meal before the symbolic paintings and over the images of the gods brought thither for the dance preparation. Then the sprinkling in the estufas being completed, four of the caciques left the north estufa and went one in each of the four cardinal directions for a distance of about a half a mile. Reaching their destination, each cacique lighted a low fire and then sat down beside it so as to face the silvery faced moon. As soon as seated each began to beat a small drum and chant to his deities. This they continued till morning.



SUN-GOD SECTION.
In one of the estufas at Jemez, N. M.

1. Clouds, the steps to heaven.
2. The bolt lightining that does not strike the earth.
3. The bolt lightning that strikes the earth. It is the red snake or Indian devil, called Savah by them.
4. The flash lightning, the god of flowers.
5. The good snake, the blue snake, the god of rain.
6. The sun, the father of the universe, and the god of all things. By the Indians he is called Patahgatziah or Pay.

(Printed in the proceedings of the Indian Academy of Science for 1903.)

At sunrise the next morning twelve chanters and a drummer entered the plaza from the south estufa, and began to sing and lift their hands towards the heavens as if in supplication. It was the beginning of the bow-and-arrow dance. Soon the dancers, two in number, a man and a woman, descended the ladder of the estufa backwards. Both had their faces, arms and all exposed parts of their bodies painted or daubed in red war paint. The woman, a virgin, let her hair hang loosely over her shoulders; her dress was of heavy black cloth, embroidered in shells, in silver badges, and in stones precious to the Indians. Her feet were bare. From her neck at the front suspended many strings of shell and turquoise beads. From the top of her head to the bottom of her dress at the back she wore a feathered cord. In her right hand she carried a bow and some arrows; in her left, a tomahawk. The man had his hair bedecked with feathers. He wore coat, leggings, and mocca-

sins, each made of buckskin, beautifully fringed, and painted in symbolic designs. At his back he carried a quiver filled with arrows. In his right hand he gripped a bow; in his left he held a heavy rawhide shield, on the front of which was painted the symbol of the sun.

Entering the plaza, the dancers crow-hopped, leaped, tripped or danced as the meaning of the chant demanded. On separate lines in front of the slowly forward-moving musicians and the populace who had joined them, they danced back and forth the full width of the public dancing area, the squaw facing and dancing in one direction, the Indian in the opposite. As they thus danced, the half of the time that they faced each other the squaw, in mimicry, shot at her adversary and drew her tomahawk to scalp him. At the same time her approaching foe defended himself with his shield and went through the motions of shooting at her with his bow. Passing each other, they each leaped and crow-hopped at a rapid pace to the turning-point in their course. As they thus danced the squaw lifted the tomahawk and the bow and arrows alternately above her head, and the Indian elevated first his shield, then his bow and arrows, with a quick, vigorous thrust. Reaching the turning-points in their respective courses, the inner dancer swung around the outer one to a line in the rear. The other dancer then wheeled about and performed in the reverse direction over the line he had just danced. When these dancers had moved in a sidewise movement across the entire plaza they retired, and a new "set" took their places and danced the very same dance over again—nothing ever gets monotonous to an Indian. In this manner, when one "set" broke up another took its place, till night commenced coming on. Then the war-captain and caciques lined the people up and prayed over them, as they sprinkled them with sacred meal. This closed the ceremonies.

THE AUGUST DANCE.

On August 2, 1900, thirteen Indians entered one of the estufas to fast and pray to complete the act of maturing the crops. On August 6 they completed their work, and, leaving the estufa, purified themselves in the river. As soon as they returned to the village there followed a plaza dance, which lasted till night. In this dance the old men danced around the drummer as they waved their hands to bring out the meaning of the song. The dancers, a man and a woman, were gaudily dressed. Both had their hair bedecked with the long feathers of the eagle's tail. The man carried a gourd rattle in one hand and a tomahawk in the other; the woman, a toma-

hawk in her right hand and a bow and some arrows in the other. In the dancing they commingled with the musicians, winding backward and forward, not unlike a snake in his crawling, as they advanced, the woman in the lead. When the woman reached the front, the bystanders threw bread and various other things into the air, to shower down upon the performers. The scrambling for these things was wonderful to see. When the residue had been trampled in the ground as a thank-offering to the gods, the musicians formed in double column and the dancers danced in the open space between the files. The principal performance was acted by the female dancer. She danced and leaped about like a jack-rabbit, lifting first the bow to heaven as she leaped to the left, and the tomahawk as she leaped to the right. This dance was another elaborate prayer for rain and for the maturing of the crops.

THE BUFFALO DANCE.

This dance consisted of two dancers, a man and a woman. The man was dressed in a buffalo hide. While dancing, he held a bow and some arrows in his right hand and a tomahawk in his left. The woman was dressed in gala attire, jeweled, and beaded. For a head covering she wore the complete neck and head skin of a buffalo. The dance was a peculiar knee-springing, foot-scraping forward and then backward movement. It lasted the whole day.

THE DANCE GIVEN IN HONOR OF THE BISHOP.

In the fall of 1900 the Catholic bishop of Santa Fe visited the village of Jemez and, while he was there, the Indians gave a dance in his honor. In this dance the dancers were men, four in number. Each of these, besides being painted and conspicuously dressed, had suspended at his back, from the crown of his head to his ankles, a line of war feathers so arranged on a buckskin cord that they kept a horizontal position. In dancing, the dancers lined up in a line abreast and acted out a vigorous stamping dance, varied occasionally by one of the dancers stepping out from the line and dancing a clumsy, grotesque jig in front of the bishop. The dance lasted about three hours.

THE BEAR DANCE.

In the fall after I went to Jemez there was a religious bear hunt, and some twenty men went to the mountains to hunt bear. After they had been gone about a week I heard a great hallooing and the firing of guns in the hills across the river west of the village. At that instant some one in the village yelled, "They have killed a bear! They are coming! A bear! A bear!" In a moment the

whole village was vigorously astir. Men, boys and squaws were on the house roofs, in the streets and plaza, and running to the river to meet the hunters, all at the same time. Excitement completely ruled. The people of the village, on reaching the river, plunged into it, swam and waded it, and made a mad rush to the leading horse of the home-coming procession, to be the first to touch the bear hide carried on this horse and to be the first to blow a hissing breath on it, so that they should receive a special blessing of the gods. On meeting the home-coming party they turned about and all entered the village in a long-drawn-out procession. On arriving at the village, the hunters rode completely around it and through each street, and stopped before each house as they sang the bear song and fired guns in the air. Completing the village in their singing, they stopped in front of the house of the hero of the hunt, the young man who got his hand on the dying bear first. As soon as they stopped, the mother came out with a club, dragged the bear hide from the saddle, put it on her shoulder, and danced a clumsy jig with it as she made a speech to those present. Finishing her dancing she threw the hide to the ground, jumped on it and pounded it with the club, while she shrieked a hideous "Wow, wow, wow," as she batted her mouth with her left hand to make the noise the more terrible. After pounding the hide for several minutes, she took it into her own house and stretched it on the floor with head near and toward the fire a moment. Then she took it and laid it in the front part of the room near the door Then each and every Indian of the village entered the house, blew his breath on his right hand, and stroked the bear hide with it. Then, lighting a cigarette, he left the room and went to the plaza to hear the hero tell of the adventures of the trip, and of how he succeeded in killing the bear.

This, I learned afterwards, is only a small part of the bear ceremonies. At another time I saw the remaining ceremonies performed, with the exception, however, that they were performed with a live cub bear. They were as follows:

One morning at daylight, in the fall of 1900, the war-captain and his aids, in broad, sonorous, strongly accented words, gave the following order to the people as they made the rounds of the village: "Fast and pray these four days. Take part in nothing pleasurable these four days. Go to your homes and do penance."

For four days no one moved about the village. The streets were deserted. The dwellings and estufas, however, were astir. Within them every one was occupied in religious ceremonies. In the

estufas the "principals" beat small drums, sprinkled sacred corn pollen before the images and symbolic paintings, and chanted prayers to those above. In the houses, before the altars, paintings, and household gods, the inmates prayed, tortured themselves, and danced without ceasing.

As the fourth day began to draw to a close, the caciques entered the plaza and kindled small fires at various places. Around each of these they set seven sticks in a line in each of the semicardinal directions. Over these they sprinkled sacred meal and prayed for a considerable time. Then they took up the sticks and, as they blew a hissing breath on them, they put them in the fire one by one.

When the stick burning was completed, four men issued from the south estufa and went one toward each of the four points of the compass. Each of these men carried a young pine in his left hand and a bowl of sacred meal in his right hand. Each pine tree thus carried has seven feathers suspended from it to the breeze, each tree and its feathers symbolizing the Jemez tribe. These trees their bearers planted quite a distance from the village. Then over them and their fluttering feathers they scattered the sacred dust, dedicating them to the moon mother, whom the Jemez believes protects his home and village. They then returned to the village.

Throughout the following night men dressed in deerskin embroidered in symbolic designs raced the streets and plaza at a coyote gallop, shaking their shell bells and gourd rattles, and sprinkling the dust of the gods toward the goddess of night.

At daylight the next morning every one in the place bathed, rinsed out his stomach with warm water, and combed and did up his long hair, according to the Indian custom. Nothing more of note occurred throughout the day.

At dusk a drum on the south estufa sounded and a new set of scenes was ushered in. "Wow, wow, wow," shrieked an old woman, as she batted her mouth with her hand to make the noise as hideous as possible. "Wow, wow," she continued, as she entered the plaza, carrying a club under one arm and a cub bear in the other. "Wow, wow," she shouted, till the people filled the plaza about her. Then, as she took the innocent little animal by the neck and shook it, she ceased her "wowing," and said:

"Long, long ago our mother, the moon, went down to the river in the early morning to get water to use in cooking breakfast for our father, the sun. She dipped the water-jar into the flowing

water and filled it nearly full. Then, to complete the filling, she took a gourd cup, as we all do, and commenced dipping up cups of water to put into the jar. Once, as she was leaning over to fill the cup, a bear, which had approached unnoticed, seized her from behind and carried her to his great cave in the mountains. In the entrance he then rolled a big rock, so that she could not escape, and there he kept her, bringing her food to eat each day.

"After she had been there a great while she gave birth to a male child, the son of the god of day. This child grew to his full maturity in this cave. He could not get out, because on leaving in the morning to search for food the bear always rolled the rock in the entrance, and on his returning he closed it behind him with the same rock. But, after obtaining his full power, this offspring of the parents of all things was able to roll the stone away and go where and whenever he pleased. He always contrived, however, to go out after the bear had departed in the pursuit of game and to return before that animal returned at the close of day.

"At first this son of the moon mother thought that he was the offspring of the bear, but his mother told him who his true father was, and related to him how it happened that she was in that miserable condition. From that time on the mother and son talked over plans of escape. At last they made up their minds what to do, and at the first opportunity they failed not to put their plans into execution.

"As soon as the bear was out of sight and hearing one morning, the son of the great mother rolled the stone from the cave entrance, put his mother on his back, and ran and ran and ran all day toward the place where the sun sets, because he knew that the sun touches the earth on all sides of the great hole at his going down. Towards night they could hear the growling bear coming in the distance. Harder and harder ran our first brother with our mother. Nearer and nearer came the bear. With open mouth he got so close to them that his breath blew in our mother's face. With a horrifying growl, the animal sprang to seize her. At the same moment our brother, with one great leap, reached the palace of the sun. The great gate closed and shut the bear out.

"But the terrible beast charged upon the gate and would have broken it in pieces had not our brother left his mother and drove him from the palace front with his mighty war-club. Bent upon having his wife, as the bear styled our mother, he then attacked the palace from the rear. On this side another one of our brothers, a son of those above, defended the edifice and drove the infuriated animal away.

THE MOON-GOD SECTION.
In one of the estufas, Jemez, N. M.

1. Clouds.
2. Bolt lightning that does not strike the earth.
3. The red snake or Indian devil.
4. The flash lightning, the god of flowers.
5. The blue snake, the god of rain.
6. The moon, the mother god of the universe (called by the Indians Ahtahwahtzah or Pah.

"To reward these defenders of the sun's wife and of his home, the Great Spirit made our first brother the morning star, and the other brother the evening star. They are in the heavens, as you have all seen them. The morning star still guards the entrance to the sun in front, the evening star the entrance in the rear.

"Ever since the rescue the bear and his descendents have been enemies of the moon and her children, and ever since that time it has been the woman's duty to destroy the bear every chance she can, to avenge the wrong done the moon mother in the long ago. Our sons capture or kill them, and we take revenge on the living animal or upon his lifeless hide."

"Wow, wow," shrieked the aged squaw again. The lookers-on "struck up" the bear chant. The drummers, who had arrived, beat the drum. The aged squaw danced the bear dance, shaking first the club towards the god of night, then the struggling little bear. The cacique sprinkled the dancer with sacred meal and

prayed to those above. The old woman dropped the bear to the ground, and as the helpless little thing howled and cried most pitiably, she beat the life out of it.

Picking up the animal's lifeless body, the old woman shook it vigorously. Then dancing across the plaza as she shrieked and batted her mouth, she entered her own house and laid the bear with head to the fire a moment. Then she took it and laid it in the rear of the room. Here the populace followed her. Hither to her house the women then rushed with baskets of eatables. Hither into this house entered the populace. As they entered each one blew his breath on his right hand, patted the bear a moment with that hand, passed on, squatted on the floor, and partook of the eatables till he had satisfied his hunger. Then all arose, lit the ceremonial cigarette, and passed out again into the public dancing area.

Here, seated in the center of the area, the Indian who had touched the bear first when it was captured was telling every one his hunting adventures and the difficulties he had in capturing the cub bear which his mother had just killed. He had told them the same story before when they had returned from the hunt, but it was still new and interesting to his hearers.

As the hero was thus relating his hunting trip, men dressed in breech-cloths, their bodies painted in symbolic colors, their hair decked with feathers, entered the plaza and began to dance in single file back and forth across the public dancing-ground, as the chief penitents beat drums, sang the bear song, and gesticulated to bring out the meaning of the same. Soon almost all of the men and boys joined the musicians, and, as all sang and shouted at the top of their voices, the whole procession, dancers included, moved toward the general feast house of the pueblo. As they neared it, the women rushed out of their houses with baskets of eatables. These they threw skyward, to shower down upon the dancers and chanters as a thank-offering to those above.

On entering the feast hall, the aged woman, with the hide of the cub bear she had killed, headed the procession, dancing, "wow-wow-ing," and batting her mouth with her hand. Thus performing, she encircled the middle space of the room twice. She then proceeded to her son, the hero, blew her breath on him in blessing, gave him the hide, and immediately left the room.

As soon as the mother had departed, the cacique sprinkled the bear skin and its possessor with sacred corn pollen, as he prayed to his gods. He then cut the left front leg from the hide and placed

it amongst his medicine curios. Then, while the populace danced from left to right around him, he laid the hide on the gound and stamped on it, as he again prayed and sprinkled the sacred dust.

The scene at once changed: With one blow, the war-captain severed the scalp from the hide and hoisted it on a pole; then around this the men danced the scalp dance for hours. This was continued till day began to dawn. Then all present seated themselves in the big house or in the street just outside of it. The breech-clothed .dancers then served them with eatables. At the rising of the sun the cermonies closed.

THE CORN DANCE.

At dusk one evening in the late summer of 1900 every man, woman and child that could walk prepared prayer-sticks, feathered them, and then all set out in a long-drawn-out procession, in Indian file, to the bank of the Rio Chiquito, north of the village. Here they tossed the sticks out from the mesa wall to the valley below. Then after them they cast the pollen of the gods, as they prayed to the rulers of heaven and earth. They then marched back to the plaza in the same manner as they had come.

Reaching the public dancing plat, the returning people lined up, and the representatives of each clan marched to its respective estufa, climbed up the ladder to its roof, and entered it through the hatchway. Then around the center post, which supports the roof, they danced and prayed to the god symbols on the walls, while the caciques sprinkled them with sacred pollen. This they continued to do till about eleven o'clock in the evening. Then they left the estufa.

On leaving the estufa some of the men went to digging holes in the plaza; some went to cutting down pine trees and dragging them to the plaza; others, under the direct guidance of the cacique, began to prepare a long pole by peeling it and painting it in colors, so that it looked much like a barber pole, except that it was many times larger. When painted they put a cross on it. Over this they suspended a large wreath of corn leaves, interwoven with spruce twigs. Meanwhile the men at the plaza set the trees in the ground so as to make a crescent-shaped grove, with open space facing the north. This completed the night scene.

At sunrise the populace gathered around the painted pole and, with a great shout, raised it to a vertical position. Then before it, that is, between it and the village, the dancers, two men alternating with three women, lined up abreast, facing the pueblo. The women were dressed in black cloth, richly embroidered in shining

stones, in shells, and in shining silver pieces. The men wore coats of bucksin and leggings and moccasins of the same material, beautifully fringed and embroidered with shells of various kinds. They also wore an outer garment of buffalo hide. The women were bareheaded; the head-dresses of the men were deerskins and feathers of the war eagle. To finish off these singularly rich and elaborate head-dresses there was added to each a pair of buffalo horns, reduced in size and weight and arranged as they grew upon the animal. To give the whole dancing suit a more striking appearance, the dancers had suspended at their backs, from the crown of their heads to their ankles, a line of war-eagle feathers so arranged on a buckskin cord that they kept a horizontal position.

When they were all lined up, the drum on the south estufa sounded. The dancers then danced slowly to the public dancing plat. Behind them the pole was laboriously carried. On reaching the plaza with it, it was set in the ground just west of the artificial grove. The dancers then retired to the nearest estufa, as the caciques prayed and sprinkled the sacred pollen to the breeze.

Soon the five dancers, the two men and the three women, reappeared and formed in column abreast inside the crescent arch with their faces turned toward the north. The musicians came next, two chanters, two drummers, and two flute players. Following these came the squaws of the place. They were gaudily painted and dressed. Sparkling ear pendents dangled from their ears, and ring upon ring of shell beads encircled their necks and reached almost to their waists in front. These squaws formed in line to dance in a great circle, having the striped pole, the grove and the musicians at its center; four men danced with the squaws, one in each quadrant of the circle. In dancing, these tripped it sidewise to the left, moving their feet about four inches at a step; while, as a countermovement, they waved their hands, first the right and then the left, to the time of the music. In these waving hands they gripped ears of corn. The moving around the entire circle by each participant completed a dancing set.

The women of the special dancing group of five tripped it lightly five steps in succession as they alternately waved ears of corn in their hands; the men vigorously stamped and shook the gourd rattles they carried in their left hands and waved the bunches of pine twigs they carried in their right hands. Then all wheeled about so as to face the east. Then five steps more were tripped or stamped; a whirl to the south was then made. This time the dancers raised their hands alternately above their heads in a vigor-

ous thrust as they danced. Wheeling so as to face the west, both hands were simultaneously elevated above the head, and five steps were emphatically stamped by both men and women. Turning on their heels so as to face the north, they began to dance as at first. Thus they continued to perform throughout the whole "set," and from set to set, till the ceremonies were brought to their consummation.

At the close of each set the actors retired to their respective estufas, and another set of performers, after they had been sprinkled with the sacred dust in the presence of the symbolic paintings of the sun edifices, came from those houses, similarly costumed, to take their places.

Just as the first set was breaking up the "funny men" came tumbling and rolling into the plaza. They were the same black and white clowns we have met with before; but in this case their bodies were decorated with corn strung on cords of buckskin and hung over their shoulders like wreaths. They were not so funny now as when we first saw them. Their principal duty at this time was to present to the gods the wrong-doings of the tribe. This they proceeded to do, in imitation, to the limit, as the lookers-on shrieked and howled with mirth. When the next dancing set formed, the clowns retired to the estufas or laid down to rest in the shade of the grove till the set was danced through. Then they became active again.

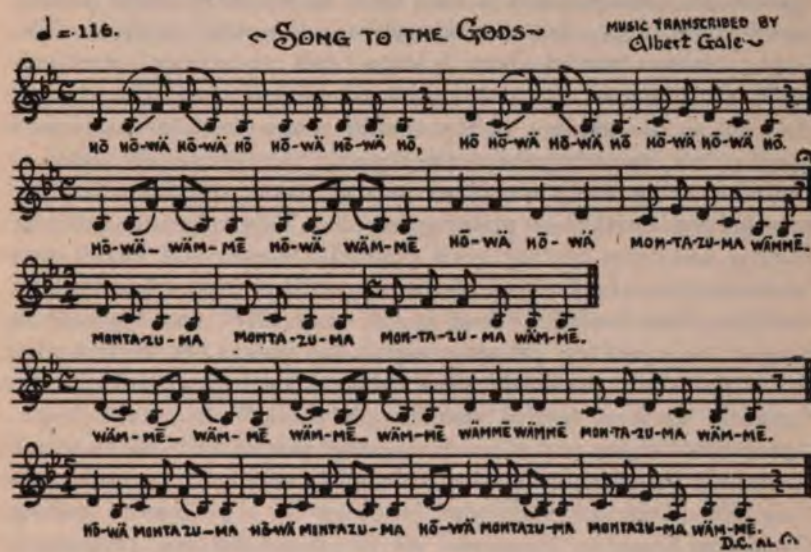
Thus, throughout the whole day, dancing scenes alternated with clown performances till evening claimed the land. Then all lined up in double column, with columns facing each other. Between these lines the caciques marched backward and forward and sprinkled all with the sacred dust. Then the columns marched to the inner room of the chief cacique's house and deposited the ears of corn they carried in their hands or had suspended at their shoulders. This corn they gave as an offering to the gods for the bountiful crop they had raised. The dance closed with this scene.

THE SNAKE DANCE.

This dance was seen at Zia pueblo, but the Jemez have it also. It is there a secret ceremony, performed at night, the same as at Zia.

Just at dusk, at the full of the moon, in August, in 1899, the antelope priests went to the place where they had collected snakes of every kind to be found in the region. These snakes they fed till they would eat no more. Then, after they had sprinkled them with sacred meal, they took snake canes having feathers suspended

at one end, and with these they rolled the snakes around, waved the feathers over them till they became bewildered and uncoiled, if they had coiled. They then picked them up one by one with their bare hands, put them in large earthen jars, covered them over in the jars with a buckskin covering, and then carried the jars on their heads to the central estufa. These they placed around the central post in that house. Then around them, in the presence of their idols and the symbolic paintings of the house, they danced, sprinkled sacred dust, and prayed for a considerable time.



MUSIC (Song)
Used in the round dances in the estufas.

Then men, dressed only in breech-cloths and bearing no weapons whatever, left the pueblo one after another, in a long-drawn-out procession, and marched with majestic tread to a point on the adobe flat about two miles northwest of the village. This being reached, all lined up abreast, facing the village. Then, at a given signal of the chief antelope priest, the snake race was on. Instantly the competitors were running like deer over the parched ground. For a few moments all kept pace with each other. Then four or five began to lead out. Then two of these made gains on the others. Then one of them began to outstrip the other. Nearer and nearer the goal they came. Across the public dancing area the leader dashed to the estufa. With one bound he leaped upon the roof, a tall, muscular, powerful Indian, with gleaming, piercing eyes. Amid

the shouting of the breathless spectators, the chief snake priest placed a wreath of pinyon twigs on his head. Triumphant and panting, he then left the roof of the estufa.

Immediately following the race, a horrible, blood-curdling ceremony begun in the estufa. There some of the snake priests, dressed in fantastic garments, stood a moment over the jars containing the slimy, wriggling, crawling snakes, sprinkled the yellow powder to the four corners of the earth, and muttered half audible incantations. Then, as they uttered a low, rattling noise, they took the reptiles from the jars and passed them to six other snake priests, as we would hand a bunch of shoestrings to another person. The latter priests squatted about a large bowl containing a dark red, medically prepared liquid in which the snakes were to be washed. As soon as the passing of the snakes commenced the musicians began a low, humming chant, the roughly handled snakes hissed or rattled, the big drum measured out the time, and the squatting priests beat it with their writhing snakes. This humming, rattling, hissing and drum-beating grew gradually louder and louder, and wilder and more barbaric and ferocious, until it burst into a fiendish shrieking and howling. Just as the excitement had reached its height the squatting priests grasped the snakes by their necks, thrust them into the liquid, drew them out again, and dashed them furiously upon a sanded circular plat called the snake home. Around this snake area stood three other priests with snake whips to prevent the hissing, rattling, infuriated reptiles from coiling as they fell. This they succeeded in doing by a process of rolling the snakes about in the sand. As the snake bathing progressed the fanatical excitement grew more and more intense. The low, murmuring song broke into wild, hideous, unearthly shrieks. The six priests grew more wild and fierce. With red-stained hands they vigorously dipped snake after snake and dashed it furiously down upon the sand till all the snakes had been washed.

The snakes were then put back into the jars and carried to a level spot about two miles up the river from the village. Following them when they set out danced the antelope priests, much in the same manner as a baboon trips about in a cage. Their almost naked bodies were streaked with white paint, as were also their faces. Rattles of various kinds were tied to their knees. Embroidered dancing skirts of white cotton hung about their loins. Necklaces encircled their necks and extended nearly to the waist line in front, and coyote skins were suspended from the waist-belt at the back. The chief antelope priest, bearing the sacred symbol of his frater-

nity, headed the dancers. Immediately behind this priest followed the bearer of the sacred medicine bowl. All the other representatives of the order carried rattles in their hands, with which they kept up a continuous noise like that made by the sacred snakes. Four times around the leveled space they danced, and sprinkled sacred meal when they had arrived there. Then they lined up to await the coming of the snake men, whom they had passed on the way. With a majestic step the latter soon came, entered the enclosed space, and lined up, facing the antelope priests.

Thus lined up, the snake men presented a grewsome, diabolical picture. Their bodies were daubed with dark red paint. Their chins were blackened, and outlined with a broad white stripe. Their breech-cloths and their moccasins were dyed red with the blood of animals. From their ankles, knees, waists and necks suspended rattling, hideous-looking objects. In their left hands they carried snake whips. In the jars on their heads they carried the snakes that were to play such a prominent part in the coming exercise.

After the lining up of the snake men, for a moment there was a breathless silence. Then at a signal they lifted the jars from their heads and poured the snakes on the ground. At the same time a deep humming of artificial rattles began, followed immediately by a vigorous chant. The chant grew louder and louder. The two lines of priests swayed slowly backward and forward towards each other, like two lines of writhing snakes. The snake whips were constantly waved over the wriggling reptiles. The chief medicine-man of the snake ceremonies strode back and forth and scattered sacred meal. The snake-priest lines suddenly broke up into groups of three. The chant at once grew louder and louder. The dancers became more and more excited. One man in each of the groups of three dropped to one knee and arose with a squirming snake in his mouth. Around the leveled area four times he then danced with his snake, as another priest of the set of three to which he belonged waved eagle feathers before the reptile to attract its attention and prevent it from sinking its fangs into its bearer. Reaching the starting-place the fourth time, the snake was dropped to the ground, and was at once dexterously picked up by the third member of the trio. Thus were the reptiles gathered up and danced with again till every one in the collection had been danced four times round the circle in the mouth of a "carrier" of each group.

As the snakes were being danced with the fourth time, the chief

priest of the ceremonies scattered sacred corn pollen in a circle on the ground. Instantly a profound silence fell over all. The snake men advanced and threw down their snakes within the yellow ring. Then at a given signal, with a howl the whole medicine line made a mad rush for the circle, and each Indian seized as many snakes as he could carry in as many ways as possible. They then all made off with them in every direction as fast as they could go, to set them at liberty to carry the prayers of the people to the divinities for rain. The snake dance is an elaborate prayer for rain.

THE CLIMATOLOGY OF KANSAS.

By T. B. JENNINGS, United States Weather Bureau, Topeka.

IN reviewing the history of a country it is customary to divide it into prehistoric and historic. In writing of the climatology of this state we will divide it into two periods; the first period extending from the earliest reliable written accounts of its weather down to the time (1887) that systematic observations and records were practically begun over the entire state.

Though the state is young it has a few records that began in the dim past. The Fort Leavenworth record began in 1836, the Fort Riley record in 1853, the State Agricultural College record in 1858, the Kansas University record in 1868, the Independence record in 1872, and the Dodge City record with 1875.

THE PREHISTORIC CLIMATOLOGY.

FLOODS.

The old river boatmen give an account of a flood in the eastern part of the territory and in the Missouri river in 1785, which passed down that river and into the Mississippi, flooding the "American bottoms" across from St. Louis, and for many years was referred to as "the great flood." Twenty-six years later the Missouri river bottoms were again flooded.

About the last of February or 1st of March, 1826, heavy rains began in what is now the southeast quarter of the state, raising the Neosho and its tributaries out of their banks and flooding their bottoms; heavy rains continued in the territory during the season. In June the lowlands near the mouth of the Kaw were flooded, owing to high water in the Kaw and Missouri rivers meeting; in the fall a destructive flood swept down the Neosho, carrying away wigwams, houses, and gathered and ungathered crops.

In 1844 occurred probably the worst floods eastern Kansas has ever experienced. Rev. Mr. Meeker, who was missionary to the Ottawa Indians, and was living on what is now the town site of the city of Ottawa, in his letters gave a graphic account of the condition of the Marais des Cygnes and the destruction wrought by it at that point. From May 7th to the 20th there were nine days of rain, and daily, 23d to 29th, inclusive; rain began again on June 7, and on the 12th the Marais des Cygnes overflowed its

banks, carrying away outhouses, fences, cattle, pigs, and chickens; the river began falling on the 14th and rising again on the 20th.

At Fort Leavenworth the rainfall for June, 1844, was 8.53 inches; July, 12 inches; August, 8.08 inches—aggregating 28.61 inches for the three months (normal annual precipitation for that place is 30.89 inches). Mr. Richard W. Cummins, of the Fort Leavenworth agency, reported to the government: "All those farming on the bottom-lands of the Kansas river, and other bottom-lands, lost their crops entirely; not only their crops, but nearly all their stock, hogs, cattle, and even horses. . . . The 'Konzas' farm mostly on the bottom-lands of the Kansas river, which was overflowed from bluff to bluff." S. M. Irvin, Indian agent in charge of the Great Nemaha subagency, reported: "The past season, you must be aware, has been a most unpropitious one for farming operations. The unprecedented fall of rain which took place in June and July, by which much of the best farming lands of the Indians was several times inundated, has been a serious drawback upon the aggregate value of the farming products."

W. W. Cone, in his Shawnee County History, speaking of the flood of 1844, says: "During the flood Major Cummings, paymaster of the United States army, wishing to cross from the south to the north side of the Kaw river, at Topeka, stepped into a canoe at about the present site of the corner of Topeka avenue and Second street, and was rowed by an Indian from there to the bluffs, near the present residence of J. M. Harding, in Soldier township, the water then being twenty feet deep over the ground where North Topeka now stands."

Mr. P. E. Chappell, of Kansas City, Mo., an old river steamboat man, states that the flood of 1844 in the Missouri river was confined to the lower river, and says: "The entire bottom from the Kaw to the mouth of the Missouri was completely submerged, and from bluff to bluff presented appearance of an inland sea." He further states that in 1845 and in 1851 there was unusually high water in the river, and all the second bottoms and low sloughs were submerged, and we find that at Fort Leavenworth 15.80 inches of rain fell during June, 1845, while in 1851 the Fort Leavenworth record shows, for May, 6.40 inches; for June, 8.16; July, 6.78, and August 5.02—a total of 26.36 inches.

THE DROUGHT.

Mr. E. C. Manning, in his paper "In at the Birth, and—" says in part: "During the winter of 1859–'60 the sun shone forty-five consecutive days through a cloudless sky upon a snowless plain.

Through the summer of 1860 the hot wind parched the soil and no harvest followed the seed-time; hence, the approaching winter brought an alarming outlook." (He was living in Marshall county then.)

Mr. Wm. H. Coffin, who settled in Leavenworth county in the '50's, speaking of the drought, says, in part: "In the great drought in Kansas, from June 19, 1859, to November, 1860, not a shower of rain fell at any one time to wet more than two inches deep, and but two light snows in the winter (1859–'60). Roads never got muddy, and the ground broke open in great cracks. There were no vegetables whatever, and a burning hot wind in July and August withered everything before it. Fall wheat came up in the spring, but withered and died. Most counties did not harvest a bushel. Low bottom-lands, where well tilled, gave some corn, but most other lands dry fodder. Prairie-grass grew until July, then all withered and died; enough to supply their needs was mostly secured from low bottom-lands. Wells, springs and streams dried up."

Hon. Geo. W. Martin, in an address before the Old Settlers' Association of Geary County, September 21, 1901, said, in part: "The changed condition in Kansas is indicated by the tone of the people during the recent dry spell. It is no easy matter to reclaim a new country, but the people of Kansas have accomplished marvels. The drought of 1860 began September 1, 1859, from which date there was no rain until September or October, 1860. . . . On the 13th of July the mercury went up to 112 and 114 degrees in the shade (the highest temperature at Manhattan was 115 degrees), and, with a hot, scorching wind, it kept at these figures for weeks. The leaves withered and fell off the trees, and eggs roasted in the sand at midday. The dates of the beginning and ending of the drought vary in locations, but it may be said that there were from twelve to fourteen months between rains."

Horace Greeley, writing in the New York *Independent*, of February 7, 1861, referring to the drought of the preceding year, said: ". . . Drought is not unknown to us; but a drought so persistent and so severe as that which devastated Kansas in 1860 is a stranger this side of the Mississippi. No rain, or none of any consequence, over an area of 40,000 square miles, from seed-time till harvest—wheat, Indian corn, buckwheat, successively deposited in the earth, to die without germination, or to start only to be blighted and wither for want of moisture."

Mrs. Susan M. Weymouth, in the *Daily Capital*, July 19, 1901, says: "The drought of 1860 gave to Kansas the ignominious name,

'droughty Kansas.' . . . It seemed for a time that the powers of heaven and earth were against us. . . . Previous to 1860 a good many trees were planted. The hot winds of that summer told on them, and in after-years the south side of the trees showed of the fearful heat which they had passed through, for there was always a dead part. That year will go down in history as having the hottest day on record. . . . It was in July, . . . a frightful day. People fled to their cellars and every door and window was closed. It was as if the wind was coming from a red-hot furnace for nine or ten hours.

"Next day we looked to see what damage it had done; birds, chickens and stock had succumbed, and the trees were badly injured; the tender things for two feet on the south side were as dead as if a fire had swept through them."

The year 1874 has been called a drought year, but it was not; it it was a grasshopper year.

(Subject to be continued as "Historic Climatology.")

NATURE PHOTOGRAPHY IN KANSAS—THE WORK OF MR. AND MISS McCOLM.

By GRACE R. MEEKER, Ottawa.

SINCE the beginnings of the science-art of photography the photographic artists have striven not only to "hold the mirror up to nature," but to fix imperishable pictures of the image reflected there. Of late years wonderful things have been accomplished. The bird woman has defied all the discomforts of hours of waiting in the forest depths to bring home pictures of the fledglings in the nest; Mr. Chapman has solved the mystery of the flamingo city, and proved, by photographs, the truth of his statements; Mr. Dugmore has caught bird and beast in intimate home life and shown them to us as they are; J. Horace McFarland, with loving care, has made us also "acquainted with the trees"; Mabel Osgood Wright has imprisoned in books the beds of wild flowers and ferns the botanist loves and dreams of.

In Kansas, also, the beauties of nature have appealed to the amateur photographer and much fine work has resulted, such as the illustrations of Doctor Quayle's nature books from pictures taken by Professor Parmenter and Almina Woods. So far as I know, no one has surpassed the McColms, as they present to us flowers, birds, animals and landscapes in Kansas.

For the artistic perfection of their work various causes are assigned. One says they know exactly how much time to give to an exposure; another says they have a fine perception of perspective; Miss McColm herself ascribes much of their success to a careful attention to detail. All these are doubtless true; but also is it true, as one of their Eastern publishers suggests: "They have, besides mechanical skill, the soul of the artist, and this they put into their pictures."

Some years ago I found in a floral magazine a page of Kansas wild-flower pictures, by G. E. McColm. The reproduction was not good, but something of artistic truthfulness, as well as the fact that they were correctly named, attracted my attention. Later, illustrated articles appeared in the Kansas City *Star* by the same author. Again the work of reproduction was poorly done, but I was much interested. Last winter I found in the *Club Member* a beautiful print, "Along the Wakarusa." This was signed "Viola McColm, Bucklin, Kan." Now, having found "the woman in the case," I

hesitated no longer, but sent a letter asking for unmounted photographs for Christmas gifts to friends. A prompt response came. with a package of these wonderful pictures to choose from. They were so singularly exact in detail, so clear and sharp in outline, and, withal, so beautiful, that I at once wished their merit might be brought to the attention of the Academy of Science, as the highest expression yet reached in our state of the photographic art beautiful. Miss McColm kindly consenting to furnish me with specimens and a few notes of their work, I am therefore enabled to have the honor of presenting them to you to-day.

YOUNG MOURNING-DOVES.

Wishing to make a collection of pictures of out-of-door subjects, Miss McColm and her brother purchased a camera in 1899. So ignorant were they of photographic art that they supposed success in negative making depended wholly upon development. A few plates were exposed in Topeka on a dull November day, immediately after the purchase of the camera. They were taken to a photographer to be developed, as they took their first lesson in development. "All were badly undertimed exposures; so we had only spoiled plates instead of negatives," she says. Aside from this one lesson, all their knowledge of picture making has been gained from

books and from personal experience, and they do all their own finishing.

They were led to photograph nature subjects from a love for nature, and as they worked they found more and more to interest them, and the desire grew to know more of the things they pictured.

CROW, SITTING.

From Miss McColm's "Notes by the Way," I quote: "A still, cloudy day is the ideal one for photographing nature subjects. But we are not often favored with such conditions—especially in western Kansas.

"In photographing flowers, where they grow, it is desirable to be able to use a small diaphragm, and give time exposure, so as to have a good depth of focus and plenty of detail. From a negative possessing these qualities one may make good bromid enlargements.

"Sometimes just at sunrise or sunset it is calm, so one may give time exposure on flowers, and with the soft light obtain very beautiful results. Often, however, the wind blows continuously, and one must be content with a rapid snap-shot in the bright sunlight. When the wind does not interfere, an umbrella is useful to soften the light, when taking nature subjects near the middle of a bright ay.

NEST OF MEADOW-LARK.

"Orthochromatic or isochromatic plates, when they can be obtained fresh, are preferred for floral or landscape work, because they give better color values.

"In photographing an adult bird on the nest, the camera may be focused on the nest and everything made ready for the exposure; then one may go some distance away and, when the bird returns, take the picture by pulling a string attached to the shutter.

"In all our experience in bird photography the Yellow-billed cuckoo is the only one that has destroyed eggs because of our intrusion."

GAGINGS OF SEWAGE FLOW AT LAWRENCE, KAN.

By W. C. HOAD and A. H. MANN, University of Kansas, Lawrence.

THE following is a report of research work undertaken by Mr. A. H. Mann, an engineering senior at the University of Kansas, the work being done under the direction of Prof. W. C. Hoad. The report is written by Mr. Mann.

Very little investigation of the actual rates of flow of sewage in cities and towns has been made where this flow was observed continuously and for a considerable period. With the exception of one set of gagings made on two main sewers in Des Moines, Iowa, the writer was unable to find any record showing that gagings have been made in this manner and on a large amount of sewers.

These gagings at Des Moines were made by J. A. Moore and W. J. Thomas, class of 1895, Iowa Agricultural College. Two main sewers were gaged continuously for fifteen days.

The gagings at Lawrence were made in order to obtain a record of the continuous flow of sewage from a purely residence district and for a considerable length of time.

The conditions at Lawrence are especially favorable for this work, as the city has separate systems of sewerage, and all the sanitary sewers empty into the same outflow sewer. Another advantage for getting a record of the flow of house sewage is the fact that there are few factories in Lawrence, and these are near the river and have private sewers.

There are about 17.9 miles of sewers in Lawrence, ranging in sizes from eight inches to twenty-one inches in diameter.

Gagings were made on the main outflow sewer at the intersection of Pennsylvania and Henry streets, this place being chosen because the entire sanitary sewage of the city passes that point. Continuous gagings were made for thirty days.

Gagings were also made on the main sewer at the intersection of Quincy and Connecticut streets, so that the flow from the purely residential district could be studied. These gagings extended over a period of thirty-eight days, beginning a short time before and continuing during the same time as those on the main outflow sewer. The gagings were made during the months of March and April, 1906, and the rainfall was about the average for this section of the country. At times of heavy rains a large amount of rain-water reaches the sewers directly through man l flush-

tank sewers and from house roofs, as is plainly shown by the rapid rise in the flow-diagram curves whenever it rained while the gagings were being taken. As the main outflow sewer empties into the Kaw river below the surface of the water, it was necessary to make the gagings in manholes. The apparatus used consisted of a right-angled triangular weir placed in the sewer, and a device for continuously recording the head of the water above the weir. The recording device was placed three feet from the weir, on the upstream side. The weirs were gaged in the hydraulic laboratory of the Kansas State University, with the water admitted in a manner similar to the way that it would reach the weirs in the sewers. The weirs were placed in the sewer where that leaves the manhole. A bicycle tube was used for packing around the weirs. When in place the bicycle tube was pumped full of air and made a water tight joint. The apparatus that recorded the height of the water consisted of a cylinder about four inches in diameter and twelve inches long, which was run by a clock. A pencil fastened to a rod extending up from the float recorded the height of the water over the weir on a record sheet placed around the cylinder.

The records were then reproduced on drawing paper by tracing them over carbon paper, so that each day's curve was superimposed on all preceding curves. From the entire series of plotted curves a single curve representing a general average could be inferred graphically. Individual curves show a number of small fluctuations, probably due to the emptying of flush-tanks. Some large fluctuations, due to a weekly emptying of a large swimming-pool, showed both the accuracy and sensitiveness of the recording apparatus. The following results were obtained:

The maximum rate of flow for the main outflow sewer and the Connecticut Street sewer were, respectively, 206 gallons and 226 gallons per capita per day, but as these were during heavy rains, they do not mean much in this work.

The maximum dry-weather rate of flow for the main outflow sewer was about 130 gallons per capita per day, and occurred between nine and ten o'clock A. M. The minimum rate of flow for the main outflow sewer was 56 gallons per capita per day, and occurred at about four o'clock A. M.

The maximum dry-weather rate of flow for the Connecticut Street sewer was about 150 gallons per capita per day, and occurred between eight and nine o'clock A. M.

The average rate of flow for the Connecticut Street sewer was 82 gallons per capita per day. The average rate of flow for the main outflow sewer was 85 gallons per capita per day.

The number of people using the sewers was obtained by counting the houses on the blocks reached by sewers and multiplying by six. This gives 8400 as the number of people using the sewers. Comparison was made with the amount of water used for domestic purposes, which was estimated at 107 gallons per capita per day, and which the writer believes is rather high, because some of the data used to get these figures seemed somewhat indefinite.

If 85 gallons be taken as the number of gallons of sewage per capita per day, and 107 gallons per capita per day taken as the amount of water used, the sewage flow is found to be about eighty per cent. of the water consumption.

THE ACCURACY OF A MODERN BALANCE AND SET OF WEIGHTS.

By H. I. Woods and Alice K. McFarland, Washburn College, Topeka.

IT would seem to be a matter of some interest to know just what may be expected of a good precision balance of modern construction, bought in open market, without any special requirements having been imposed on the maker or dealer. The construction, as regards material and workmanship, perhaps may be judged to some extent by general appearances to a critical observer, and by facility of adjustment and smoothness of operation. The excellence of the instrument in the precise determination of weights, depending largely on the equality of lengths of arms and smoothness of the sensibility curve, can be determined only by careful tests.

The balance chosen for the tests here reported is by Paul Bunge, Hamburg, and is of the type described in his catalogue as number "0." It is also described in Watson's Physics (pp. 109, 110). The length of the beam is nominally 13 cm., and is of the short-arm, high-stayed triangle form. The rider scale, also 13 cm. long, extends along the entire front of the beam, and is numbered from 0 to 10, each tenth of the length being subdivided into 10 parts, or 100 in all. The rider weighs nominally 5 mg., and is to be at the "0," beam horizontal and no load. The pointer is long, 25.5 cm. from the central knife edge.

As ordinarily used the balance has the usual sensitiveness of $\frac{1}{10}$ mg. but a delicacy of $\frac{1}{100}$ mg. may be readily secured by placing a small cylindrical weight on the top of an arm extending vertically upward back of the center of the beam. The swings are then read by a microscope extending through the front of the case at an angle of forty-five degrees and focused on a small ivory scale attached to the pointer about 4 cm. from its lower end. This scale is 10 mm. long and is divided into 100 parts, microscopic figures being placed at each tenth division. This fine scale, in addition to its use in very precise weighings with the fine adjustment, enables one to make more accurate determinations with the ordinary $\frac{1}{10}$ mg. sensitiveness than is possible by reading the swings in the ordinary way on the coarse scale. The vibration time being, of course, the same, readings may be made with almost as great facility through the microscope as on the coarse scale.

The testing of the balance and weights has thus far consisted of the following determinations:

1. The testing of the weights by the Bureau of Standards.
2. The sensibility curve.
3. The values of certain weights from laboratory sets, both for purposes of calibration and to determine how closely values may be repeated.
4. The ratio of the arms.

The details of the above determinations are as follows:

1. *Testing of the Weights.*—The weights were also by Bunge, supplied with the balance, and of the usual type. They were sent to the Bureau of Standards for comparison with the United States standards. The following is taken direct from the certificate of the bureau:

"The weights designated below have been compared with the United States standards and have the following corrections:

Designation.	*Correction.*	*Designation.*	*Correction.*
100 grams	−0.4 mg.	500 mg	−0.015 mg.
50 "	−0.5 "	200 "	−0.034 "
20 "	−0.32 "	100^1 "	−0.068 "
10^1 "	−0.22 "	100^2 "	−0.034 "
10^2 "	−0.11 "	50 "	+0.070 "
5 "	−0.31 "	20 "	−0.013 "
2^1 "	−0.12 "	10^1 "	−0.027 "
2^2 "	−0.09 "	10^2 "	+0.012 "
1 "	−0.00 "	5^1 " rider	+0 076 "
		5^2 " "	+0.080 "

"A (+) correction means that the weight is heavier than the nominal value; a (—) correction that it is lighter by the amount indicated. When applied to the nominal value of a weight, the correction will give its mass referred to the international kilogram."

2. *Sensibility Curve.*—Readings for the sensibility curve were made in the usual way, using loads of even numbers of grams from 0 to 200. The microscopic scale was used, sensibility being taken as the number of divisions displacement for one mg. additional load. In the tabulation of results, "L" indicates the load; "S," divisions displacement per mg.; "M," means of five preceding values of "S." The values of "S" are the means of independent determinations by each of the authors of this paper. However, but one set of values was gotten by each observer, and it is probable that the irregularities are due quite as much, or more, to accidents of observation as to lack of uniform action of the balance. The curve traced from the values of "S" given shows a rather rapid drop from 0 to about 30, a tolerably uniform value slightly below 5 from 30 to about 130, and from this point to the maximum load

of 200 the gradually decreasing value indicates, it would seem quite clearly, the lowering of the centroid by the flexure of the beam under the increasing load. Perhaps the lowering of the values from 0 to 30 may be explained by a straightening out of the stays of the beam, or at least a drawing taut. It is quite likely that, owing to the form of the beam already mentioned, that of a triangle, the knife edges might be drawn slightly out of line with no load on the beam. After this the beam remains straight to about 130 gms. load, when it begins to bend slightly under the increased strain. Such an explanation would account for the three parts of the curve which appear rather marked. The data for the curve follow:

L.	*S.*	*M.*	*L.*	*S.*	*M.*	*L.*	*S.*	*M.*	*L.*	*S.*	*M.*
0	5.4		50	4.9		100	5.0		150	4.8	
2	5.2		52	5.0		102	4.9		152	4.8	
4	5.2		54	5.0		104	4.8		154	4.8	
6	5.2		56	5.0		106	4.9		156	4.8	
8	5.0	5.20	58	5.0	4.98	108	5.0	4.92	158	4.8	4.80
10	5.1		60	5.0		110	4.9		160	5.1	
12	5.1		62	4.9		112	5.0		162	4.9	
14	5.3		64	4.9		114	5 0		164	4.7	
16	5.1		66	4.9		116	4.9		166	5.0	
18	5.0	5.12	68	5.1	4.96	118	4.9	4.94	168	4.9	4.92
20	5.3		70	4.9		120	5.0		170	4 8	
22	5.1		72	4.8		122	4.9		172	4.8	
24	5.0		74	5.2		124	4.9		174	4.8	
26	5.1		76	4.9		126	5.0		176	4.7	
28	5.0	5.10	78	4.9	4.94	128	4.9	4.94	178	4.7	4.76
30	4.8		80	4.9		130	4.9		180	4.7	
32	5.2		82	4.9		132	4.9		182	4.6	
34	5.0		84	5.0		134	4.9		184	4.6	
36	4.9		86	4.7		136	4 8		186	4.6	
38	4.9	4.96	88	5.0	4.90	138	4.8	4.86	188	4.8	4.66
40	5.0		90	4.9		140	4.8		190	4.7	
42	5.0		92	4.9		142	4.8		192	4.7	
44	5.2		94	5.0		144	4.8		194	4.7	
46	4.9		96	4.9		146	4.8		196	4.7	
48	5.1	5.04	98	5.0	4.94	148	4.8	4.80	198	4.7	4.70
50	4.9		100	5.0		150	4.8		200	4.7	

3. *Values of Laboratory Weights.*—The weights were as follows: 1, 20, 50 and 100 gms.; combinations were also made to give 120, 150 and 170 gms. The headings of the columns explain the data.

Nominal values.	Determined weights.		Differences.
	W.	McF.	
gm.	*gm.*	*gm.*	*mg.*
1	0.99984	0.99983	0.01
20	20.00065	20.00061	0 04
50	49.99854	49.99852	0.02
100	99.99991	99.99992	0.01
120	120.00051	120.00048	0.03
150	149.99835	149.99842	0.07
170	169.99907	169.99903	0.04

Each weight given is the means of weighings right and left—not the square root of the product. But one determination of each weight was made by each observer. The adjustment of the balance was for the lower sensitiveness of $\frac{1}{10}$ mg. It was planned to make determinations for a sensitiveness of $\frac{1}{100}$ also, but lack of time prevented. All values have been carried out at least one place further than shown in the above figures.

4. *Ratio of the Arms.*—The ratio of the arms has been computed from the values from 20 to 170, with the results given:

Load.	Ratio of arms, L/R.	
	W.	McF.
20	0.999995	0.999997
50	7	7
100	6	7
120	8	8
150	5	8
170	8	8
	0.9999965	0.9999975

Mean value of L/R, 0.999997.

Further determinations are desired, especially for the higher sensitiveness, no values of which are given, and but few of which have been secured.

The weighings were all made without any precautions to secure dryness of the air in the balance case.

CHANGE IN THE CLIMATE OF KANSAS.

By F. H. Snow, University of Kansas, Lawrence.

IN reiteration of his statements before the congressional committee regarding the subject of a change of climate in the region which includes the states of Kansas and Nebraska, Dr. Willis L. Moore, chief of the United States Weather Bureau, has issued a pamphlet. Among these statements I note the following: "We find, right in the arid regions, that during a long period of observations, thirty, forty or fifty years, the average rainfall of the first ten years is precisely the same as the average of the last." Yet, in the tabular statement which concludes Doctor Moore's pamphlet, only the last thirty years are included, although the records of three of the stations named cover respectively forty-eight, thirty-nine and forty-one years. I submit that a fair comparison of facts bearing upon so important a subject as the change of climate should include the entire period of observation.

My own records at Lawrence cover a period of thirty-nine years, from 1868 to 1906. During the first ten years of this period, from 1868 to 1877, the average annual rainfall was 34.91 inches; during the last ten years, 1897 to 1906, it was 38.16 inches, giving an increase of 3.25 inches per annum. But a more satisfactory method of comparison is to divide the entire period of observation into two equal parts. The total rainfall at Lawrence for the first half of the thirty-nine years, from January 1, 1868, to July 1, 1887, was 672.81 inches, while during the second half of the period the total was 743.67 inches, giving an increase of 70.86 inches in the total precipitation. This makes the average annual rainfall for the first half of the period 34.50 inches, while for the second half it is 38.14 inches, an increase of 3.64 inches, or more than ten per cent. And this is the result, although the rainfall at Lawrence for the year 1906 was only 28.50 inches—more than 8 inches below the average for the thirty-eight preceding years. This notable deficiency for 1906 occurred in the eastern portion of the region west of the ninety-fifth meridian, in which region Doctor Moore says that the rainfall for 1906 was excessive in all that vast stretch of territory.

Notwithstanding the facts brought out by my own observations, which have been regularly forwarded to the chief of the Weather Bureau, at Washington, at the end of each month and year, Doctor Moore states that "the rainfall has neither increased nor diminished

by amounts worthy of consideration." This statement, however, may be considered correct with regard to the western third of Kansas and Nebraska, as shown by the records of Dodge and North Platte; but it is not correct in regard to the eastern and central portions of those states, where the breaking and cultivation of the soil upon a large scale and the great increase of forestation have combined to produce conditions favorable to an increased rainfall. In the western portions of Kansas and Nebraska the conditions are practically the same to-day as they were in the eastern portions of those states when settlement first began.

There never has been a better opportunity to test the question of the effect of the sudden human occupation of an agricultural region upon climatic conditions than has been afforded in eastern and central Kansas and Nebraska during the last fifty years. Three millions of people now occupy this agricultural region, where fifty years ago the entire area was unplowed prairie. When I came to Kansas, in 1866, to begin my life-work as a member of the faculty of the State University, the only timber consisted of a narrow belt along each stream; and during the late autumn and winter I often counted at night as many as fifty to seventy simultaneous prairie-fires from my study windows in the University buildings, on the summit of Mount Oread. At that time by daylight, from the same point of view, every house in the city of Lawrence was plainly visible from foundation to roof, while at the present time the buildings, although greatly increased in number, are completely concealed from view by the foliage of the multitudinous shade-trees. The surrounding country also has been so changed in appearance by the growth of trees under human direction as no longer to bear the remotest resemblance to the original prairie surface.

Not only has the rainfall increased, but the atmospheric humidity has also increased. The average relative humidity for the first half of the period of my observations was 68.76 per cent., while during the second half it had risen to 73.21 per cent. When I came to Kansas, in 1866, and for several years thereafter, no dew was deposited upon the grass until toward morning, and one could walk through the grass at any time before midnight without wetting one's shoes. Of late years, the dew generally begins to be deposited on the grass before the twilight is over, as in the Eastern states, thus corroborating the observed increase in the atmospheric humidity.

In regard to the velocity of the wind, Doctor Moore, in his hearing before the congressional committee, stated that he was quite

certain that there had been no change in the general high velocity, for an altitude of 50, 60 or 100 feet, although the trees would restrict the velocity of the wind near the ground. In his pamphlet just issued he states that "an examination of the wind records in Kansas and Nebraska show that the last fifteen years have not been quite so windy as the fifteen years previous, but that it is not safe to assume that a permanent decrease in the wind velocity has taken place." My own records of the wind velocity began on July 1, 1872, when an excellent recording apparatus was installed upon the roof of the north dome of the main building of the University of Kansas, 105 feet above the ground, the ground itself being 250 feet above the broad valley of the Kansas river. This apparatus has been carefully kept in order under my personal direction during the entire 34½ years, and its results have been compared with, and corroborated by, those of a standard anemometer of the signal service pattern, which for fifteen years was in operation at the same elevation. If we adopt the method of comparison used by Doctor Moore in his rainfall statistics, and divide the thirty-four years into ten-year sections, we have the following results:

The average annual wind run of the first ten years (1873–'82) was 138,052 miles; of the second ten years (1883–'92), 131,040 miles; of the third ten years (1893–1902), 122,012 miles; of the last four years (1902–'06), 100,212 miles. But, as stated in regard to the rainfall, it seems to be a more satisfactory method of comparison to divide the entire period into two equal parts. By this method we find the average annual wind run of the first seventeen complete years (1873–'89), to be 134,389 miles, and of the second seventeen years (1890–1906), 119,252 miles. This gives an average reduction of 15,137 miles per annum for the second half of our period of observation as compared with the first half. Stated in another way, the average velocity of the wind for the first seventeen years was 15.34 miles an hour, while for the second seventeen years it was only 13.61 miles an hour, giving a reduction of nearly twelve per cent.

It thus appears that the observations of nearly forty years, made continuously by and under the direction of the writer, indicate a gradual change in the climate at Lawrence, Kan. And as this locality presents a typical illustration of the climatic conditions of eastern Kansas, it is safe to infer that the same changes are taking place over the entire region of which it forms a part. The rainfall and atmospheric humidity have increased, and the wind velocity has decreased. The change in the rainfall and wind

velocity has been in each case more than ten per cent., while the increase in the atmospheric humidity has been more than six per cent. And these results are based not "upon the recollections of the oldest inhabitants," but upon the faithful records of actual observations.

VI.

APPENDIX.

ACCESSIONS TO THE ACADEMY LIBRARY, 1905 AND 1906.
ADVERTISEMENT OF VOLUMES ISSUED BY THE ACADEMY.
INDEX TO VOLUME XX, PART II (1906).

APPENDIX.

ACCESSIONS TO THE LIBRARY.

JANUARY 1, 1905, TO DECEMBER 31, 1906.

ALABAMA.

Map of Coal-fields.

CALIFORNIA.

BERKELEY.

University of California:

Bulletins of the Department of Geology, vol. IV, Nos. 1 to 19; vol. V, Nos. 1, 2.
Bulletins of the Department of Physiology, vol. II, Nos. 3 to 16; vol. III, Nos. 1 to 17.
Bulletins of the Department of Pathology, vol. II, Nos. 7, 8, 9.

SAN FRANCISCO.

California Academy of Sciences:

Preliminary Report, Earthquake Commission.
Geology, vol. III, Nos. 16 to 22.
Zoology, vol. II, No. 2.
Memoirs, vol. V, No. 1.
Chronicles, vol. VII.

STANFORD UNIVERSITY.

Contributions to Biology from the Hopkins Seaside Laboratory:

Register, 1905–'06, vols. 4, 7, 19; Trustee Series, No. 12.
Four papers by Vernon L. Kellogg.

COLORADO.

BOULDER.

University of Colorado:

Studies, vol. II, Nos. 3, 4, 1904; vol. III, Nos. 1, 2, 3, 4.
Science Series, Nos. 33–35.
Quarter-centennial Celebration.

COLORADO SPRINGS.

Colorado College:

Studies, vols. XI, XII.
Social Science Series, No. 5.
Engineering Series, vol. I, Nos. 1, 2.

DENVER.

Colorado Scientific Society:

Proceedings, vol. VII, pp. 341 to 346, containing index.
Frontier Monthly, January to August, vol. VIII, pp. 1 to 166.
Mineral Notes, No. 3.

GOLDEN.

Bulletin of School of Mines:

Vol. I, Nos. 1, 2, 4; vol. II, No. 1.

Report State Bureau of Mines, 1903–'04.

DELAWARE.

Bulletins from Experiment Station:

Nos. 68 to 75.

DISTRICT OF COLUMBIA.

ON.

my of Sciences:

Memoirs, vol. VIII.

Vol. VI, pp. 333 to 437; vol. VII, pp. 1 to 396, and index.

Vol. VIII, pp. 1 to 196.

Reports, 1904, 1905.

Memoirs National Academy of Science, 1904.

Biological Survey:

Bulletins 26 to 54.

Vol. XVIII, pp. 1 to 226.

United States Department of Agriculture:

Annual Reports of Secretary for 1904, 1905, 1906.

Year-books, 1904, 1905.

Bulletins, Circulars, Reports for 1905-'07, from the following divisions: Agrostology, Animal Industry, Biological Survey, Botany, Chemistry, Entomology, Experiment Stations, Foreign Markets, Forestry, Plant Industry, Publications, Soils, Weather Bureau.

Primers of Forestry, parts I and II.

Diseases of Cattle.

Annual Report Experiment Stations, 1904.

Field Operations, Bureau of Soils, 1904.

Bulletins 159 to 276.

United States Department of the Interior:

United States Geological Survey.

Twenty-fourth Annual Report, four parts, vol. XLVIII; text and part 2, 1902-'03.

Twenty-fifth Annual Report, one part, 1903-'04.

Mineral Resources of the United States, 1903, 1904.

Reports on Mines and Quarries, 1902.

Proceedings National Museum, vol. 28.

Report of Director, 1904-'05.

Professional Papers, 29, 32 to 55.

Water-supply Bulletins, 97 to 171.

Isopods of North America.

Smithsonian Institution:

Annual Reports, 1900-'01, 1901-'02, 1902-'03, 1903-'04.

Smithsonian Miscellaneous Collections, vols. XLVI and XLVII.

Contributions to National Herbarium, vols. 8, 10, and 11.

Experiments with Low Temperatures.

Proceedings United States National Museum, vol. 30.

Special Bulletins, Hydroids—Oceanic Icthyology, 2 vols.

Instruction to Collectors.

Bureau of Ethnology:

Annual Reports, vols. 20, 21, 22, two parts.

Bulletins 28, 29, 32.

Twenty-third Report, 1901-'02.

United States Navy Department:

Report of Supt. of Naval Observatory, 1901; vol. IV, pts. I-III; 1905; 1906.

United States Coast and Geodetic Survey:

Annual Reports, 1901, 1902, 1903, 1904, 1905.

Report of Lighthouse Board, 1904.

Central Electric Light and Power, 1905.

United States Census Department:

Mortality Census Reports of Insane, Blind, Paupers.

Special Reports—Census.

Streets and Electrical Railroads.

Benevolent Institutions, 1904.

Bulletins 11 to 61.

United States Coast and Geodetic Survey:

Reports of Superintendent, 1905, 1906.

Public Roads, Bulletins 41 to 63.

Reports on Porto Rico and Hawaii, 1905.

DISTRICT OF COLUMBIA.

WASHINGTON.

Weather Bureau:
- Long Range Forecasts.
- Monthly Weather Review, vols. 32, 33, 34.
- Rainfall Charts.

Philosophical Society:
- Transactions, vol. XXI, part 1.
- Bulletin XIV, pp. 1-450.

Commissioner of Education:
- Report, 1903, vols. I and II.
- Report, 1904, vols. I and II.

Library of Congress:
- Bulletin 15.
- Catalogues of Specimens of Fossils, Minerals, Rocks, and Ores.

Bureau of Commerce and Labor:
- Bulletins 16 to 40; 20 to 31.
- Annual Report of Lighthouse Board, 1905.
- Interstate Commerce Work, also, "Brief."
- Census of Manufactures.
- Alaska Experiment Station.
- London Hamilton Exploring Expedition, Maps.
- Proceedings of United States National Museum, vols. 28, 30.

INDIANA.

Geological Report, pp. 801-867.
Catalogue Rose Polytechnic, 1906.

ILLINOIS.

CHICAGO.

Armour Institute of Technology:
- Year-books, 1905-'06, 1906-'07.

Chicago Academy of Sciences:
- Bulletin, Notes on Permian.

Field Columbian Museum:
- Anthropological series, vols. 4, 5.
- Botanical series, vols. 2, 3.
- Geological series, vols. 3, 4, 5.
- Zoological series, vols. 4, 5.

Library Bureau:
- John Crerar Library, 1894-1905.
- Public Libraries (monthly), vols. 9, 10.

University of Chicago:
- Department of Geology, Journal of Geology, vols. 12, 13, 14.

ROCK ISLAND.

Augustana Library Publications, 1906, Nos. 4, 5.

URBANA.

Illinois State Laboratory of Natural History:
- Bulletin, vol. VI.
- Chemical Survey and Water-supplies.

IOWA.

DAVENPORT.

Davenport Academy of Sciences:
- Early History Eng. Soc., vols. IX, XI.

DES MOINES.

Iowa Naturalist, vols. 1, 2.

KANSAS.

LAWRENCE.

University of Kansas:
- The Kansas University Quarterly.

University Geological Survey:

KANSAS.

MANHATTAN.

Agricultural College:

Bulletins, Nos. 115-150.

The Industrialist, vols. 31, 32, 33.

TOPEKA.

Reports of the various state departments for 1906.

Stock-breeders' Directory, 1905.

Reports State Boards—Agriculture, Health, etc.

Weather Bureau.

Bank Commissioner.

Kansas Historical Collections, vol. IX.

Statue of Ingalls.

Proceedings.

EMPORIA.

Early Rocks of Eastern Kansas, L. C. Wooster.

KENTUCKY.

Rock Products, vols. II and III.

LOUISIANA.

Louisiana at Purchase Exposition.

MAINE.

PORTLAND.

Society of Natural History:

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ANNOUNCEMENT.

We issue volume XX, part II, with confidence that it will be received as a valuable contribution to scientific literature and a credit to the Academy. Owing to the pressure of legislative printing, it has been impossible to complete the work sooner. This volume will be sent to all members who have not neglected their annual dues and to all corresponding institutions. There are two constant sources of growth in our library: First, scientific publications secured by exchanges; and second, the rapidly multiplying publications of the agricultural and other departments at Washington.

The annual reports of the Smithsonian Institution and many other of these accessions are of great and permanent value, and we have now about 500 such volumes, foreign and domestic, ready for the binder. Our library needs a new book-stack to accommodate this enlargement and make it possible to put our books where they can be readily consulted.

A provisional catalogue, compiled under direction of Prof. F. B. Dains, will soon be issued, showing the scientific resources of libraries in the state-house and in Washburn College. This will be printed under direction of the state librarian, and cannot fail to be a great help to scientific workers in this vicinity.

The usual announcement of our next annual meeting will be sent out some time in August, and all members are urged to communicate with the secretary if they have a choice as to the time of meeting or can give any suggestion that will contribute to the success of our next meeting, at Emporia. We ought to increase our membership, so as to include at least all Kansans who are interested in the progress of science. The nominal fee of membership is amply repaid by our annual volumes, and it rests with members to show how much these can be improved. Local branches of the Academy, with more frequent meetings and greater opportunity for discussion, might stimulate our work and widen its influence.

J. T. LOVEWELL.

TOPEKA, KAN., March, 1907.

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